

May 21, 1974

M. B. RINGLEY

3,811,995

METHOD OF HIGH YIELD SEMICHEMICAL PULP PRODUCTION

Filed Sept. 5, 1972

4 Sheets-Sheet 1

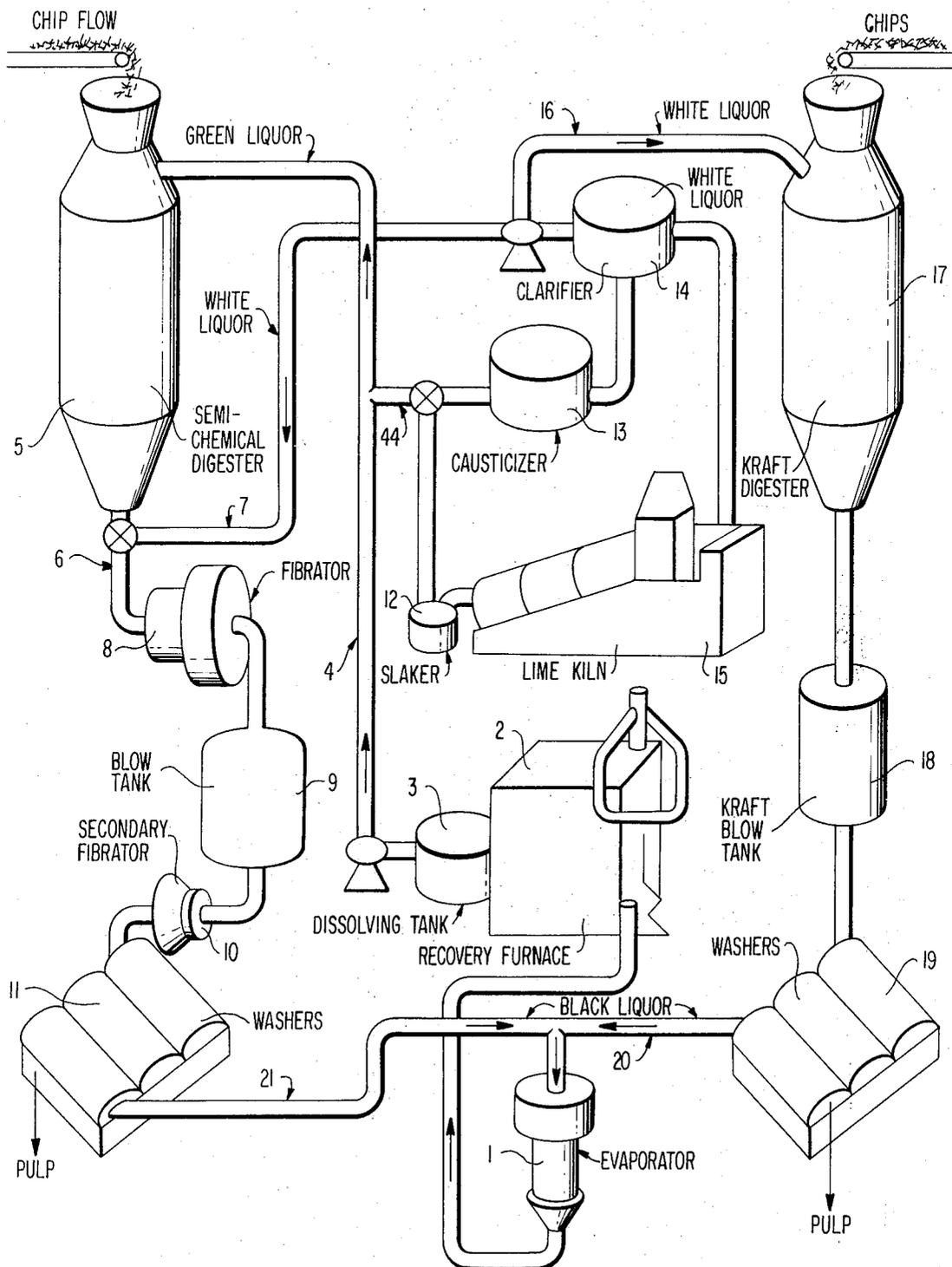


FIG 1

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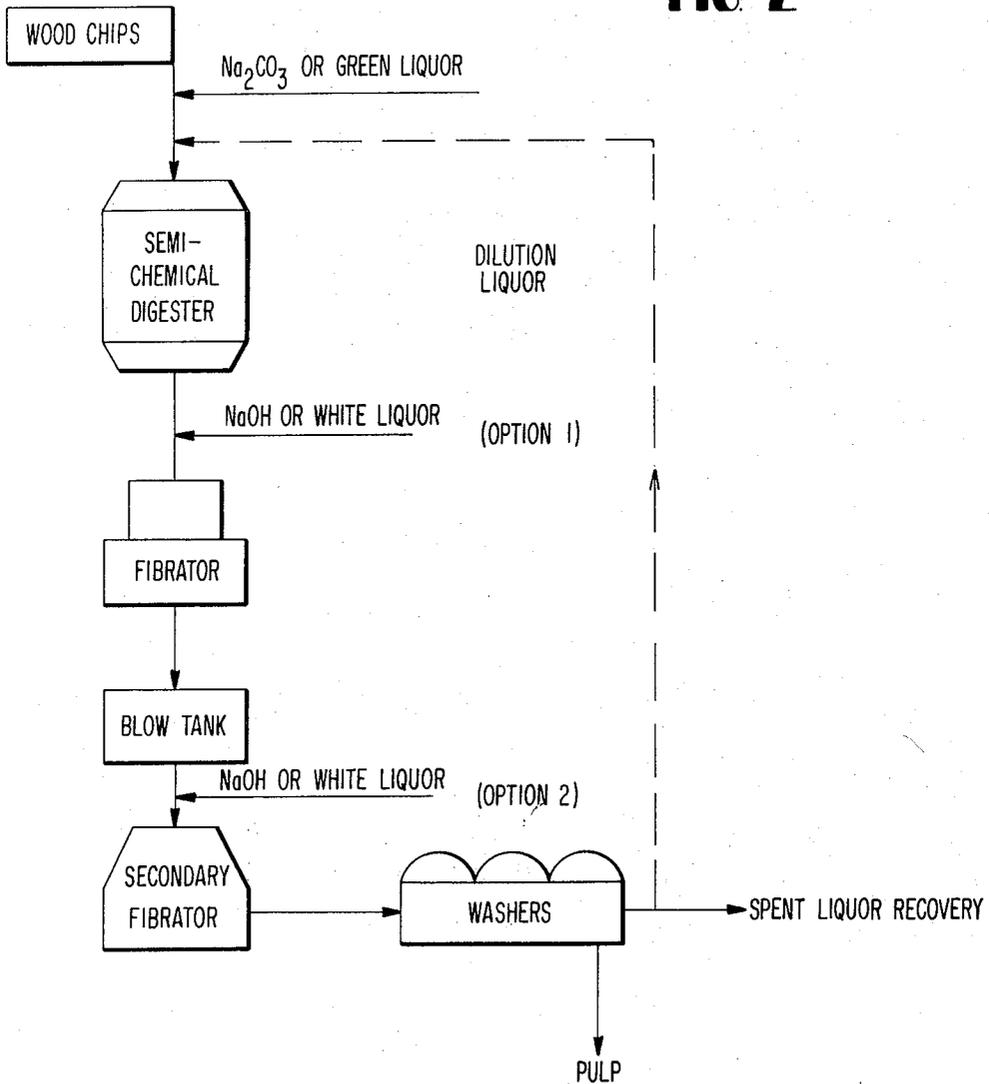
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METHOD OF HIGH YIELD SEMICHEMICAL PULP PRODUCTION

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4 Sheets-Sheet 2

FIG 2



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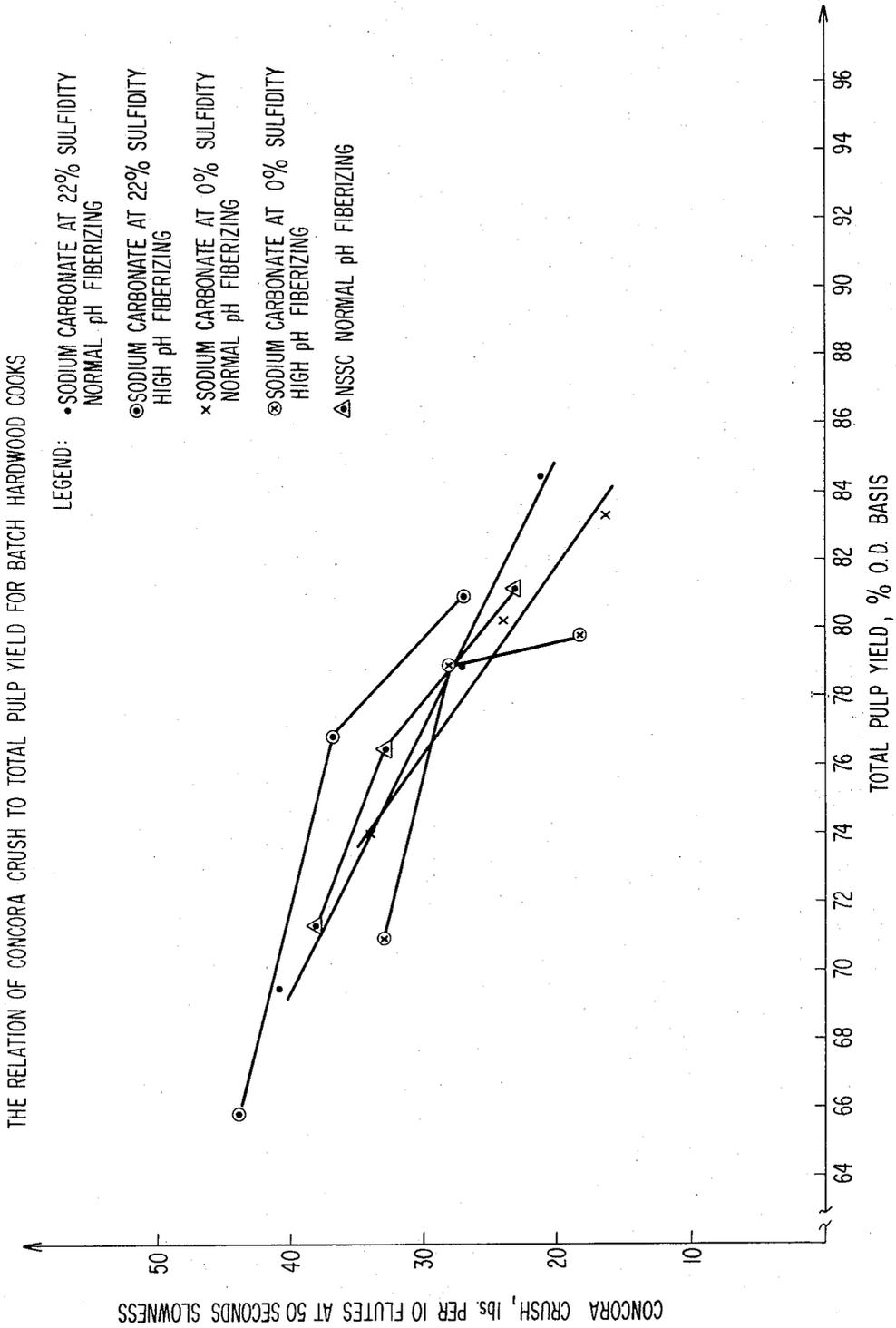
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METHOD OF HIGH YIELD SEMICHEMICAL PULP PRODUCTION

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FIG 3



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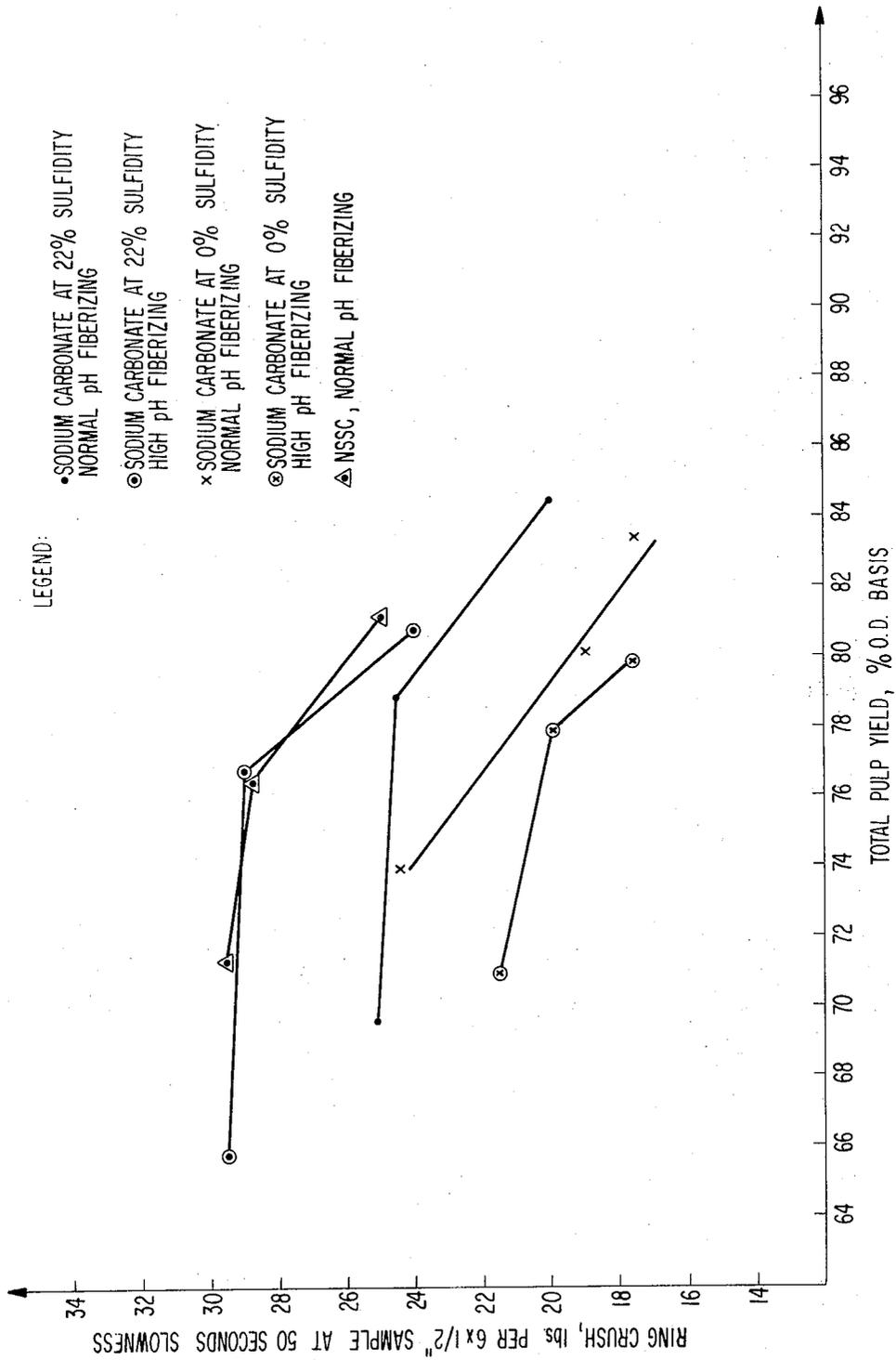
METHOD OF HIGH YIELD SEMICHEMICAL PULP PRODUCTION

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4 Sheets-Sheet 4

FIG 4

THE RELATION OF RING CRUSH TO TOTAL PULP YIELD FOR BATCH HARDWOOD COOKS



1

2

3,811,995
**METHOD OF HIGH YIELD SEMICHEMICAL
 PULP PRODUCTION**

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10 Claims

ABSTRACT OF THE DISCLOSURE

A process is set forth for producing pulp at a yield of 60 to 85% which comprises: combining in a pressure vessel, either the batch or continuous type, comminuted wood with a solution of cooking liquor comprising sodium ions wherein 60–100% thereof, measured as sodium oxide, is sodium carbonate and 0 to 30% thereof is sodium sulfide; cooking the mixture under pressure and heat until 40–15% of the organic components of the wood are solubilized; adding sufficient sodium hydroxide, either as sodium hydroxide or in the form of kraft white liquor, to the cooked mixture to raise the pH between 9 and 13; and mechanically fiberizing in the presence of the sodium hydroxide and spend cooking liquor, the cooked comminuted wood. The resulting pulps are useful for making unbleached structural paper, such as fluted medium for corrugated board, like 9 point corrugated medium.

BACKGROUND OF THE INVENTION

(1) Field of the invention

This invention relates to an improved process for producing pulp from wood chips. More particularly, this invention relates to a semichemical pulping process which is the combination of steps of cooking wood chips with sodium carbonate solutions, and thereafter adding a sodium hydroxide containing solution, to raise the pH to between 9 and 13, to assist mechanical fiberizing, to reduce odor emissions, improve pulp washing and paper strength, and in some cases reduce fiberizing power requirements.

(2) The prior art

Depending on the desired characteristics of the resulting paper product, wood pulping may be performed by exclusively mechanical means, thermochemical means or by a combination of the two, e.g., semichemical means. Characteristics distinctive of these processes include the degree of lignin removal and yield (weight of oven dry pulp per given weight of oven dry wood). Since mechanical pulping essentially constitutes a shredding process, lignin removal is negligible and yields are in excess of 95%. Chemical pulping, on the other hand, has the objective of removing as much lignin as practicable thereby yielding only 40 to 65% pulp from a wood charge.

Definitively, semichemical pulping is a two-stage process that requires a mild chemical treatment of wood chips to weaken the lignin bond on the cellulose fibers followed by a mechanical operation to complete the separation. Semichemical pulps are particularly useful and economical for the production of unbleached, high strength structural paper such as fluting medium for corrugated sheet and containers. Historically, semichemical pulps were first made in the 1880's by chemically treating the wood chips with sulphurous acid and bisulphite followed by grinding.

Currently, such pulp is dominantly prepared by either the neutral or acid sulphite semichemical process wherein the primary chemical agent of delignification is a 120 to 200 grams/liter solution of sodium bisulphite or sodium sulphite. The function served by the alkaline compound in the neutral process is to neutralize the released

organic acids which are highly corrosive to process equipment in addition to preserving pulp strength by preventing acid hydrolysis. The usual sulphite semichemical "cook" is conducted in batch digesters at 160 to 190° C. for 1 to 2 hours with cooking liquor to wood ratios of less than 4:1. This period may be shortened considerably if a preimpregnation period is used, followed by a 15 to 20 minute transit through a continuous digester at from 170° C.—200° C.

From the limited perspective of mere pulp preparation, the sulphite semichemical process is very economical in comparison to the product value. Only the barest minimum of chemical and mechanical energy is expended with relatively simple capital equipment. From the broader view of waste chemical recovery, the otherwise economically attractive sulphite process becomes more marginal. Chemical pulping processes, specifically the "kraft" or alkaline sodium sulphide-sodium hydroxide process, have, by virtue of greater lignin removal, sufficient heat value in combustible organics to support an incineration process of cooking chemical recovery. To recover used cooking chemicals exclusively from the sulphite process in a similar manner would require the addition of purchased fuels.

The recovery of NSSC spent liquor alone is generally not economical because of the low heat yield in the recovery process and high capital cost to recover equipment. Furthermore, some NSSC recovery systems are limited to producing chemical by-products for sale rather than for reuse in the process. NSSC recovery systems which generate cooking liquors suitable for NSSC cooking are available, but are undesirably complex and costly. Accordingly, the installation of costly recovery equipment for NSSC plants alone can generally be justified only for the elimination of pollution problems that result if the spent liquor is sewerred.

In recent years, it has been discovered that by operating a sulphite pulping operation in conjunction with a kraft operation of 3 to 4 times greater production, expended chemical from both processes may be recovered from a common or "cross" recovery plant. This solution is not won without difficulty however. Because sodium input is beyond that which is normally lost through production and attritional losses there is cyclic accumulation of sodium ion in the kraft system. Accumulation of these chemicals normally limits the amount of NSSC production compatible with a kraft mill. Furthermore, mixing NSSC spent liquor with kraft black liquor causes corrosion, evaporation scaling, lignin precipitation and lowering the heat value of the combined black liquors. As in the usual kraft recovery process, black liquor, the colloidal substance drained from a finished "cook" of wood pulp, is evaporatively concentrated and the combustible organics therein ignited in an incinerator to generate heat for the foregoing evaporation step. The residue of combustion predominately comprises sodium carbonate and sodium sulfide. When solubilized, this residue, or smelt, comprising a majority thereof as sodium carbonate, is characterized as "green liquor." To continue the kraft recovery, the green liquor is subsequently causticized with lime and clarified to convert most of the sodium carbonate to sodium hydroxide.

A technique sometimes used to avoid the accumulation of sodium is direct sulfiting of the green liquor from a kraft-semichemical cross-recovery plant. In the direct sulfiting of green liquor to compound semi-chemical cooking liquor, a portion of the solubilized smelt following incineration is contacted with sulfur dioxide to disassociate some of the sodium from the carbonate and generate sodium sulfite.

Ideally, then, what has been desired by the semichemical wood pulping industry is a truly closed recovery system for cooking chemicals and preferably one that may be

operated in conjunction with a kraft system as a cross-recovery plant.

The most obvious and direct approach to the problem is with the kraft system green liquor and this approach has previously been followed without significant success. First, softening wood and other fibrous material by treatment with a solution of sodium carbonate containing sulfur was taught in U.S. Pat. 1,626,171 to S. D. Wells. Richter et al., in U.S. Pat. 2,694,631 contended that "up to now, no method of manufacturing chemical wood pulp is known in which the green liquor can be used as a cooking liquor for the wood, this being the sole cooking liquor." The Richter et al. green liquor cooking process specified as a first step immersed treatment of the chips in an aqueous solution of 12-30% sulfur dioxide at 4 to 10 hours, 100-110° C., 150-200 p.s.i.

Other investigators, such as Winczakiewicz et al. in "Papier, Carton, Cellulose" 14, No. 1 at pages 96-98 (January/February 1965) discuss the successful manufacture of semichemical pulps using sodium carbonate. On the other hand, vapor phase green liquor pulping in connection with a kraft cross recovery process was investigated by S. Vardheim, see "Paper ach Trä," vol. 9 (1967) at pages 613-619. Vardheim's process required a preimpregnation period of the chips in the same green liquor solution as the cook which had a sodium ion concentration of 57% sodium carbonate (as Na₂O).

Since an essential feature of this invention relates to the addition of sodium hydroxide or white liquor to the cooked, comminuted wood prior to fiberizing, it is pertinent to point out as prior art U.S. Pat. 3,388,307 to A. J. A. Asplund et al., which discloses a method of manufacturing uncooked wood pulp which consists of adding chemical in solution or in suspension to heated chips prior to passage of the chips between grinding members in connection with a subsequent bleaching process. Included among the chemicals that may be added are, suspensions of hydroxides of alkaline earth metals.

It is therefore the general object of this invention to provide a semichemical pulping process which combines cooking with a liquor containing predominately sodium carbonate followed by mechanical fiberizing in a solution containing sodium hydroxide. Another object of this invention is to provide a process for producing unbleached structural paper using mild cooking with a minimum of fiberizing power. Still another object of this invention is to provide a green liquor semichemical pulping process wherein an alkaline solution is added prior to fiberization of the cooked wood, combined with a kraft pulping process and cross-recovery system. An even further object of this invention is to provide a semichemical process for producing pulps of 60-85% yield suitable for converting into corrugated medium having Concora Crush and Ring Crush properties essentially equal to conventional NSSC pulps.

Other objects, features, and advantages of this invention will be evident from the foregoing detailed description and accompanying drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

The invention, both as to its organization and method of operation, may be best understood by reference to the following detailed description of the invention taken in conjunction with the accompanying drawing in which:

FIG. 1 is a overall flow diagram of an embodiment of a preferred practice of this invention showing a cross-recovery combination of green liquor pulping and conventional kraft pulping including the addition of white liquor after green liquor cooking;

FIG. 2 is a general process schematic diagram illustrating semichemical cooking and chemical addition to fiberizing, supported by an independent recovery plant;

FIG. 3 is a graph showing the relationship of Concora Crush to total pulp yield; and

FIG. 4 is a graph showing the relationship of Ring Crush to total pulp yield.

SUMMARY OF THE INVENTION

The present invention relates to a process for producing semichemical pulping wherein about half or less of the lignin is removed from the wood chips for a yield of 60-85%. A process is set forth for producing semichemical pulp which comprises; combining in a pressure vessel, either the batch or continuous type, comminuted wood with a solution of cooking liquor comprising sodium ions wherein 60-100% thereof, measured as sodium oxide, is sodium carbonate, e.g., kraft green liquor, and 0 to 30% thereof is sodium sulfide at a liquor to wood ratio of between 6-3:1; cooking the mixture under pressure and heating until about 40-15% of the organic components of the wood are solubilized, normally 10 minutes to 4 hours at 150-180° C.; adding sufficient sodium hydroxide, either as sodium hydroxide or in the form of kraft white liquor, to the cook mixture to raise the pH between 9 and 13, preferably about pH 12, and mechanically fiberizing the cooked, comminuted wood. At equal yields of of pulp; Concora Crush and Ring Crush with the addition of white liquor all remain high; whereas, benefits are gained by having reduced odor emissions, improved pulp washing, corrosion inhibition and occasionally reduced power. The resulting pulps are useful for making unbleached structural paper, such as fluted medium for corrugated board.

DETAILED DESCRIPTION OF THE INVENTION

It has been found that the addition of sodium hydroxide or kraft white liquor to wood chips cooked with sodium carbonate or kraft green liquor, after cooking and prior to fiberizing to raise the pH between 9 and 13, among other benefits, produces pulps having equivalent Concora Crush and Ring Crush to NSSC pulps. An outline of one of the preferred methods of carrying out this invention with green liquor in actual commercial practice in a cross-recovery system in conjunction with a kraft process is shown in FIG. 1.

Referring now to the drawings, there is shown in FIG. 1 the cross-recovery combination of green liquor pulping and conventional kraft pulping including the addition of white liquor after the green liquor cook. Spent cooking liquor from the washers of both the kraft cook and the semichemical cook are merged and enter evaporator 1 wherein the water in the spent cooking liquors is evaporated to concentrate the spent liquors to a solids concentration of about 50% to 70% by weight solids. The concentrated spent liquors are passed to the recovery furnace 2 and the organic components burned. The heat from the combustion of the organic materials may be useful in evaporator 1.

Ash or smelt from recovery furnace 2 is dissolved in an aqueous solution in dissolving tank 3 to solubilize the soluble inorganic compounds and in one embodiment may be used as the cooking liquor. This aqueous solution of inorganic compounds is characterized in the industry as "green liquor," the inorganic compounds thereof comprising sodium carbonate, sodium sulfide and a host of other sodium and sulfur bearing compounds. In terms of weight percentages of total sodium ion, measured as sodium oxide, the concentration of sodium carbonate in green liquor may comprise from 45 to 90% of the total sodium ion but more commonly, a concentration of 60 to 80%. Sodium sulfide constitutes approximately 0 to 30% of the sodium compound total with the remainder thereof being sodium hydroxide, sodium sulfite, sodium sulfate, sodium thiosulfate and numerous other impurities.

Following the dissolving step, that portion of the green liquor production necessary for the semichemical digester cooking charge is pumped directly to the semichemical digester 5 via line 4. The semichemical digester may be

a continuous digester such as a Kamy, or a conventional batch type digester as shown.

The green liquor used for the semichemical pulping should have an alkali concentration in the range of 60 to 150 grams/liter as sodium oxide. Although either water or filtrate from the semichemical pulp washers containing dilute black liquor may be used for concentration adjustment (not shown), green liquor alkali concentrations in the order of 100 to 150 grams/liter are normal as received from the dissolving tank. As is also normal for conventional green liquor, the sodium carbonate concentration of the total alkali constitutes 60 to 90%. Although the significance thereof is not apparently relevant, 0 to 30% of the total alkali comprises sodium sulfide with any remainder being sodium hydroxide, sodium sulfite, sodium sulfate and sodium thiosulfate.

The above-described green liquor is applied to comminuted hardwood having 40 to 60% moisture content (predominately oak, gum and maple) in the form of chips, shavings or sawdust at a weight ratio wherein the total of tritatable sodium compounds expressed as sodium oxide is about 2% to 12% of oven dry wood for cooking in a batch digestion vessel. Steaming or preimpregnation of the wood although unnecessary, is optional. The process therefore may require only simple, direct charging of the cooking vessel with wood and green liquor. Digester retention time is between 10 minutes to 4 hours, preferably 15 minutes to 2 hours, at 140° C. to 200° C., preferably 150° C. to 180° C. These same cooking conditions are also applicable when the cooking liquor is 100% by weight sodium carbonate rather than green liquor. The foregoing range of cooking conditions produce yields in the order of 70 to 85%. For continuous digestion at the same liquor concentration, the cooking parameters are maintained within those described above for batch cooking with adjustments made according to the specific equipment available and pulp properties desired.

Following discharge from semichemical digester 5, the mixture of cooked comminuted wood and spent cooking liquor enters line 6 where sufficient kraft white liquor is added via line 7 to raise the pH between 9 and 13, preferably about pH 12. The mixture is conducted under pressure into conventional fibrator 8 which renders the wood to coarse pulp. Thereafter, the coarse pulp is depressurized into blow tank 9 with a sudden reduction to atmospheric pressure. After the blow tanks, the coarse pulp is further mechanically worked by secondary fibrator 10, either disc or cone type, and finally washed over conventional rotary drum washers 11. An alternative embodiment of this invention (not shown in FIG. 1) is to add the white liquor to the coarse pulp before entering secondary fibrator 10.

The portion of green liquor not used for semichemical pulping is directed via line 44 to causticizer 13 along with chemicals from slaker 12, and is subsequently causticized with calcium hydroxide slurried from lime in lime kiln 15 and clarified in white liquor clarifier 14 to convert the dominance of the sodium carbonate to sodium hydroxide. Chemicals from the causticizing sub-cycle is characterized as "white liquor" and constitutes the primary delignification solution of the kraft digestion process. The constituency of white liquor comprises approximately 65-80% sodium hydroxide, 15%-30% sodium sulfide and about 5% sodium carbonate, relative to the total sodium oxide equivalent.

The white liquor is pumped from white liquor clarifier 14 and the stream divided with a portion passing through line 7 to the green liquor cooked wood as described above and the remainder to kraft digester for a conventional kraft cook with the cooked pulp passing to blow tank 18 and thence to rotary washers 19. The spent liquor from the semichemical cook is low in compounds deleterious to the kraft cook and is useful to the kraft chemical charging as a bulking and pH buffering agent. Therefore,

the kraft black liquor in line 20 merges with the semichemical spent liquor in line 21 to form the spent cooking liquor fed to evaporator 1, thereby completing the cycle.

Referring now to FIG. 2 there is shown the general process schematic diagram of the broad aspects of this invention as supported by an independent recovery plant. Comminuted wood as chips, sawdust or savings are combined with sodium carbonate or kraft green liquor along with any water or spent cooking liquors for dilution and passed to the semichemical digester of either the batch or continuous type. The batch-type cooks are conducted at a 6-3:1 liquor to wood ratio for 10 minutes to 4 hours, preferably 15 minutes to 2 hours at 140° C. to 200° C., preferably 150° C. to 180° C. After cooking, the cooked chips and spent cooking liquor are directed under pressure from the digester and mixed with sufficient sodium hydroxide or kraft white liquor (option 1) to raise the pH to between 9 and 13, preferably above 12. This mixture is then passed to a fibrator where the cooked wood is mechanically liberated into coarse pulp. After liberation of the fibers by mechanical agitation the mixture under pressure passes to the blow tank where the pressure is released. The thus liberated pulp fibers may then be further mechanically fiberized and are then passed to washers to separate the pulp from the spent cooking liquor. As an alternative to supply sodium hydroxide or white liquor prior to fibrator, the sodium hydroxide or white liquor in an alternative embodiment of this invention (option 2) may be supplied to the blow tank or just prior to secondary fiberizing to accomplish, in principle, the same purpose but with slightly less effect.

The purpose of adding sodium hydroxide or white liquor prior to mechanically separating the cooked wood into fibers is to raise the pH of the mixture which thereby ionizes dissolved and colloidal lignin enabling better washing and at the same time reduces odor emissions. As will be shown in the foregoing examples surprisingly as strong physical properties of the pulp are obtained as those of conventional NSSC pulps. Furthermore, the spent cooking solution at pH 9-13 reduces equipment corrosion.

In terms of pulp properties from the aforescribed green liquor semichemical process with addition of white liquor or sodium hydroxide to raise the pH prior to the fiberizing, tests have indicated an equal or higher Concora Crush and Ring Crush strengths relative to the neutral sodium sulfite (NSSC) semichemical cook, and that alkali addition assists fiberizing by reducing power requirements without substantially affecting pulp yield, as will be seen in the following examples.

Although sulfur or sulfur compounds are unnecessary to the semichemical cook of the present invention as indicated by the 100% sodium carbonate cooks in one of the following examples, the presence of sulfur compounds is not deleterious to the semichemical cook and is necessary to the kraft process. Therefore, sufficient elemental sulfur necessary for the kraft cook may be added to the recovery cycle, if required.

Since the green liquor semichemical cooking and recovery cycle is compatible with the cooperative kraft cycle, it is only necessary to supplement the flow cycle for attritional losses. In this considerable latitude is allowed to take advantage of current economics and market conditions. For example, supplemental sodium may be introduced to the system at any one of the several points as shown in FIG. 2. Excess green liquor from other kraft mills may be added directly to the semichemical green cooking liquor flow stream or to the combined flow stream following the incinerator. Sodium hydroxide in the form of lye or caustic soda may be added directly to the kraft white liquor. Sodium sulfate in the form of natural salt cake may be added to the cross-recovery stream before the incinerator. Refinery waste comprising large concentrations of sodium sulfide may be added to the kraft portion of the cycle between the causticizer and clarifier or

directly to the semichemical green cooking liquor flow stream.

The high pulp yield characteristics of this and other semichemical pulping techniques normally render independent recovery plants uneconomical. Due to the highly simplified flow stream of the present invention, however, it is possible that an independent recovery plant may be supported thereby notwithstanding the possible need to purchase supplementary fuels. Such is the process schematic represented by FIG. 2, wherein evaporation and incineration are the only process steps necessary to reconstitute expended cooking liquor. The economic advisability of a FIG. 2 system would have to be developed on an individual installation basis.

Although it would seem, in the light of current economics, that the primary economic thrust of this invention is for high yield pulps not intended for bleaching, it is nevertheless obvious that suitable bleaching pulps may also be made thereby. By extending the cooking interim beyond those of the examples or other similar changes to the cooking conditions, greater quantities of lignin may be removed from the natural wood matrix. Conversely, time periods longer than described but with weaker concentrations of sodium carbonate should also produce good high yield pulps.

NSSC liquor at several levels and cooked. The cooking conditions and resulting yields are shown in Table I below.

TABLE I.—BATCH COOKING HARDWOODS WITH NSSC LIQUOR

	SO ₂ charge as Na ₂ O		
	3.7%	5.5%	7.25%
Liquor to chip ratio, ml./g.-----	3.5:1	3.5:1	3.5:1
Cooking temperature, ° C.-----	150	159	168
Time to temperature, minutes-----	60	73	85
Time at temperature, minutes-----	60	60	60
Total cooking time, minutes-----	120	133	145
Residual cooking liquor, pH-----	7.2	7.5	7.9
Residual SO ₂ as Na ₂ O, g./l.-----	5.3	7.8	9.8
Fiberizing, pH-----	<7.2	<7.5	<7.9
Fiberizing power, H.P.-day/ton-----	11.8	9.9	6.1
Pulp yield, percent on O.D. wood-----	81.2	76.4	71.2
Pulp rejects, percent on pulp (14 cut)-----	0.9	1.1	0.9
Screened pulp kappa number-----	139	136	130

EXAMPLE 2

In this example a hardwood mixture (ratio of 1:1) of oak and gum were combined with sodium carbonate cooking liquor and varying Na₂O charge. Cooks were made at both 100% sodium carbonate (0% sulfidity) levels, and 78% sodium carbonate (22% sodium sulfide) levels (representing a typical green liquor cook). The cooking conditions and corresponding pulp yields are shown in Table II.

TABLE II.—BATCH COOKING AND FIBERIZING OF SODIUM CARBONATE HARDWOOD PULPS WITHOUT ADDITION OF 5% WHITE LIQUOR PRIOR TO FIBERIZING

	Na ₂ O charge					
	2%		5%		10%	
Cooking liquor sulfidity, percent-----	22	0	22	0	22	0
Liquor to chip ratio, ml./g.-----	3.5:1	3.5:1	3.5:1	3.5:1	3.5:1	3.5:1
Cooking temperature, ° C.-----	150	150	150	150	168	168
Time to temperature, minutes-----	60	60	60	60	85	85
Time at temperature, minutes-----	60	60	60	60	60	60
Total cooking time, minutes-----	120	120	120	120	145	145
Residual cooking liquor, pH-----	7.0	7.0	8.4	8.4	8.9	8.6
Fiberizing, pH-----	<7.0	<7.0	<8.4	<8.4	<8.9	<8.6
Fiberizing power, H.P.-day/ton-----	20.6	21.4	15.6	19.8	6.7	15.2
Pulp yield, percent on O.D. wood-----	84.5	83.3	78.9	80.2	69.6	74.0
Pulp rejects, percent on pulp (14 cut)-----	0.7	1.3	0.8	1.2	0.7	0.6
Screened pulp kappa number-----	147	144	157	156	163	165

The invention will be described in greater detail with the aid of the following examples. These examples are set forth to show for comparative purposes pulps made from cooking with NSSC liquor, cooking with sodium carbonate and green liquor and cooking with sodium carbonate/green liquor with white liquor addition before fiberizing.

EXAMPLE 1

A mixture of hardwood chips comprising a mixture of oak and gum were combined in a batch digester with

EXAMPLE 3

This example clearly illustrates the advantages of this invention. In this example another hardwood mixture of oak and gum in an equal mixture were combined in a batch digester with sodium carbonate (both 22% sodium sulfide and 0% sulfidity) at several concentrations of Na₂O charge. The cooking conditions and corresponding pulp yields are shown in Table III. After cooking a solution of kraft white liquor amounting to 5% Na₂O on wood was added to the cooked pulp to increase the pH above 12 and subsequently mechanically fiberized.

TABLE III.—BATCH COOKING AND FIBERIZING OF SODIUM CARBONATE HARDWOOD PULPS WITH ADDITION OF 5% WHITE LIQUOR PRIOR TO FIBERIZING

	Na ₂ O charge					
	2%		5%		10%	
Cooking liquor sulfidity, percent-----	22	0	22	0	22	0
Liquor to chip ratio, ml./g.-----	3.5:1	3.5:1	3.5:1	3.5:1	3.5:1	3.5:1
Cooking temperature, ° C.-----	150	150	150	150	168	168
Time to temperature, minutes-----	60	60	60	60	85	85
Time at temperature, minutes-----	60	60	60	60	60	60
Total cooking time, minutes-----	120	120	120	120	145	145
Residual cooking liquor, pH-----	7.0	7.0	8.5	8.4	9.1	8.7
Fiberizing, pH-----	>12	>12	>12	>12	>12	>12
Fiberizing power, H.P.-day/ton-----	16.8	17.2	15.8	14.8	6.8	12.9
Pulp yield, percent on O.D. wood-----	80.7	79.8	76.8	77.9	65.8	71.0
Pulp rejects, percent on pulp (14 cut)-----	1.0	3.7	1.0	1.6	1.2	0.5
Screened pulp kappa number-----	148	144	149	154	135	161

The pulps from Examples 1-3 were made into handsheets (TAPPI standard). The handsheet densities at 75% total pulp yield and 50 seconds Williams slowness was comparable for all pulps. At the same comparison conditions almost all the strength properties (Concora Crush shown in FIG. 3, burst factor, and tensile) were approximately equivalent to those that can be obtained from NSSC pulp. However, the 0% sulfidity sodium carbonate pulp did have a tendency to be weaker and high pH fiberizing tended to give higher Concora Crush for the 22% sulfidity sodium carbonate batch pulp. The only significant difference found was that the Ring Crush, shown in FIG. 4 of the batch 22% sulfidity sodium carbonate liquor pulp was lower than that from the batch NSSC pulp. Raising the fiberizing pH to 12 brought the Ring Crush to the level of that obtainable from the NSSC pulp. The 0% sulfidity sodium carbonate pulps were low in Ring Crush.

The results show that the fiberizing power to achieve an approximate 1% reject level was lower for the pulps fiberized with the addition of 5% white liquor to the blow tank as shown in Table IV which compares the power requirements to produce the pulps of Examples 2-3.

TABLE IV

Batch cooking and fiberizing of sodium carbonate hardwood pulps without addition of 5% white liquor prior to fiberizing

	Na ₂ O charge					
	2%		5%		10%	
Cooking liquor sulfidity, percent.....	22	0	22	0	22	0
Fiberizing, pH.....	<7.0	<7.0	<8.4	<8.4	<8.9	<8.6
Fiberizing power, H.P.-day/ton.....	20.6	21.4	15.6	19.8	6.7	15.2
Pulp yield, percent on O.D. wood.....	84.5	83.3	78.9	80.2	69.6	74.0
Pulp rejects, percent on pulp (14 cut).....	0.7	1.3	0.8	1.2	0.7	0.6

Batch cooking and fiberizing of sodium carbonate hardwood pulps with addition of 5% white liquor prior to fiberizing

Fiberizing, pH.....	>12	>12	>12	>12	>12	>12
Fiberizing power, H.P.-day/ton.....	16.8	17.2	15.8	14.8	6.8	12.9
Pulp yield, percent on O.D. wood.....	80.7	79.8	76.8	77.9	65.8	71.0
Pulp rejects, percent on pulp (14 cut).....	1.0	3.7	1.0	1.6	1.2	0.5

While the invention has been described and illustrated herein by references to various specific materials, procedures and examples, it is understood that the invention is not restricted to the particular materials, combinations of materials, and procedures selected for that purpose. Numerous variations of such details can be employed, as will be appreciated by those skilled in the art.

Having thus described the invention, what is claimed is:

1. A method of producing high yield semichemical pulp which comprises:

(a) combining comminuted wood with an aqueous cooking solution having 60 to 150 grams per liter total alkali concentration measured as sodium oxide wherein 60 to 100% thereof comprises sodium carbonate and 0 to 30% thereof comprises sodium sulfide;

(b) cooking in a closed vessel the mixture of comminuted wood and aqueous cooking solution at a liquor to wood ratio of between 6 to 1 and 3 to 1 at a temperature from 140° C. to 200° C. until 40 to 15% of the organic compounds of the wood are solubilized;

(c) adding a sufficient amount of a solution containing sodium hydroxide to the semichemical cooked wood to raise the pH to between 9 and 13; and

(d) mechanically fiberizing the semichemical cooked wood in the presence of the spent cooking solution and the solution containing sodium hydroxide to separate the fibers.

2. The method of producing high yield semichemical pulp as described in claim 1 wherein said total alkali concentration of aqueous cooking solution is 100 to 150 grams per liter measured as sodium oxide and 60% to 90% thereof comprises sodium carbonate.

3. The method of producing high yield semichemical pulp as described in claim 1 wherein said aqueous cooking solution is kraft green liquor.

4. The method of producing high yield semichemical pulp as described in claim 1 wherein said aqueous cooking solution is sodium carbonate.

5. The method of producing high yield semichemical pulp as described in claim 1 wherein said cooking is accomplished in a batch-type digester at a temperature between 150° C. to 180° C. for from 10 minutes to 4 hours.

6. The method of producing high yield semichemical pulp as described in claim 1 wherein said solution containing sodium hydroxide is kraft white liquor.

7. The method of producing high yield semichemical pulp as described in claim 1 wherein a sufficient amount of solution containing sodium hydroxide is added to raise the pH to at least 12.

8. The method of producing high yield semichemical pulp as described in claim 1 wherein said aqueous cooking solution is solubilized smelt from an expended pulping solution recovery furnace.

9. The method of producing high yield semichemical pulp as described in claim 1 wherein the cooked wood is partially fiberized before addition of the sodium hydroxide and subsequent secondary fiberization.

10. A process for producing high yield semichemical pulp which comprises:

(a) mixing together the spent cooking liquors from a kraft pulping process and a semichemical pulping process;

(b) evaporating said spent cooking liquors to a solids concentration of about 50% to 70% by weight solids;

(c) incinerating said evaporated cooking liquors to form a smelt comprising 60 to 98% sodium carbonate measured as sodium oxide, and 2 to 30% sodium sulfide;

(d) dissolving said smelt in an aqueous solution to a total alkali concentration of 60 to 150 grams per liter, as sodium oxide;

(e) directly combining a portion of said dissolved smelt with comminuted wood at a liquor to wood ratio of 6:1 to 3:1 and digesting at 140° C. to 200° C. until 15 to 40% of the organic compounds of the wood are solubilized;

(f) causticizing the remaining portion of dissolved smelt to form white liquor;

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- (g) adding sufficient white liquor to the semichemical digested wood to raise the pH to between 9 and 13; and
- (h) mechanically fiberizing the semichemical digested wood in the presence of the spent digesting liquor and white liquor.

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