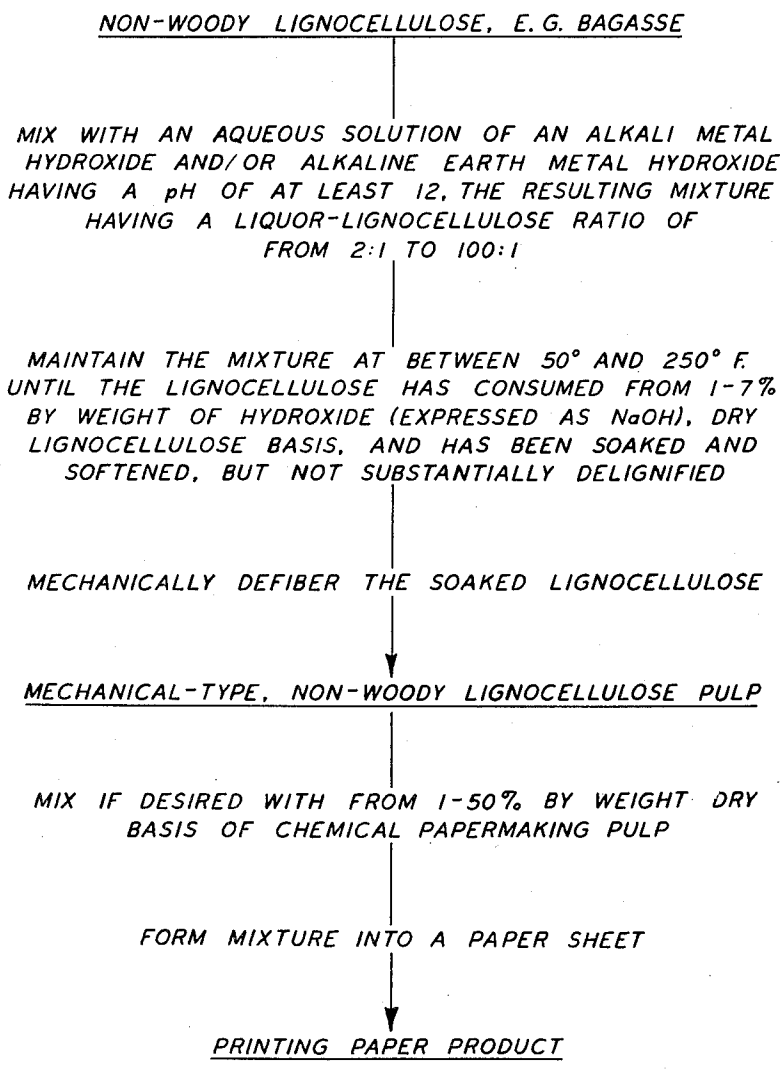
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PRINTING PAPER AND PROCESS OF MAKING THE SAME

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PRINTING PAPER AND PROCESS OF MAKING THE SAME

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This invention relates to paper products especially adapted for use as printing paper, and to a process for making such products. More specifically, it relates to printing papers such as newsprint and book paper which contain in lieu of groundwood pulp a substantial proportion of mechanical-type pulp derived from fibrous, non-woody, lignocellulose plant material, and to a process of making such papers.

As is well known, newsprint-type printing paper conventionally contains from 75–90% by weight groundwood and from 10–25% of a chemical wood pulp. The groundwood pulp supplies the required opacity, smoothness, resiliency and bulk to the paper, while the chemical wood pulp provides the necessary strength. However, the high consumption of newsprint made by present processes requires enormous quantities of pulpwood and results in the depletion of the forests, particularly with respect to preferred softwood species employed in the manufacture of groundwood.

It accordingly is the general object of this invention to provide a printing paper made entirely from non-woody lignocellulose pulp available at low cost in large quantities, the printing paper product being characterized by superior opacity, bulk, strength, and printing qualities, and to provide a process for the manufacture of such a paper.

It is another important object of the present invention to provide a mechanical-type, non-woody, lignocellulose pulp which may be employed per se in the production of newsprint or other printing paper of commercial quality without the inclusion of any proportion whatsoever of chemical wood pulp, and to provide a process of making such a pulp.

It is the essence of the present invention that newsprint or other printing papers may be made without groundwood, using instead a mechanical-type pulp made from non-woody lignocellulose. In executing the present invention, the non-woody lignocellulose is wilted and softened in an alkaline hydroxide solution without being substantially delignified. It then is mechanically defibered. By controlling the reaction conditions as described herein, a pulp is produced which may be used as a replacement for groundwood, or even employed per se in the production of a commercial grade printing paper without the inclusion of pulps of other classes.

Considering the foregoing in greater detail:

The non-woody mechanical-type pulp which is the essential constituent of the presently described printing paper may be derived from fibrous, non-woody, lignocellulose plant material such as whole or depithed bagasse, straws, grasses and the like, preferably bagasse, or wheat straw. For those non-woody lignocellulose materials such as bagasse which inherently contain pith, substantial removal of the pith by any suitable procedure is desirable to improve paper machine operations, pulp quality, and pulp handling charcteristics.

As is apparent from the accompanying flow plan, in converting the fibrous raw materials of the foregoing classes into mechanical-type pulp by the presently described procedure, the material first is reduced to small

pieces, if desired, and then placed in a suitable vessel containing an aqueous solution of an alkaline hydroxide comprising essentially at least one member of the group consisting of the alkali-metal hydroxides and alkaline-earth metal hydroxides. Examples are sodium hydroxide, potassium hydroxide, lithium hydroxide, calcium hydroxide, barium hydroxide, and strontium hydroxide. These may be used singly or in admixture with each other. Sodium hydroxide is a preferred member of the group. Bleaching agents and other chemicals useful in imparting desirable properties to lignocellulose pulps may be included in the liquor as desired.

The foregoing alkaline hydroxides are employed in amount sufficient to produce a liquor of the desired concentration, i.e. a concentration sufficient to soak and soften the lignocellulose to the desired extent under the selected reaction conditions. In general, a liquor containing from 0.1 to 25%, preferably from 0.2 to 3% by weight of the hydroxide, calculated as NaOH may be used. A sufficient quantity of the liquor is employed together with the non-woody lignocellulose to produce a mixture having a liquor-lignocellulose ratio of from 2:1 to 100:1, preferably from 4:1 to 12:1.

The alkaline hydroxide liquor employed should have a pH of at least 12 before mixing with the lignocellulose. This makes possible the production of a pulp having sufficient strength to be used in the manufacture of printing papers without the inclusion of any chemical pulp whatsoever.

The bagasse or other non-woody lignocellulose is treated with a liquor having the indicated characteristics at a temperature which lies broadly between 50° and 250° F., preferably between 150° F. and the boiling point of the liquor at normal atmospheric pressure. The treatment is continued for a time sufficient merely to soften and wilt the lignocellulose without causing any substantial delignification thereof. In other words, it is carried on until the lignocellulose has consumed only from 1–7%, preferably from 3–6%, of its own dry weight of the alkaline hydroxide content of the liquor.

The duration of treatment is determined by such factors as the identity of the lignocellulose, the concentration of the liquor, the liquor-lignocellulose ratio, and the temperature. In general, however, where the other reaction conditions are as indicated above, a reaction time at temperature of from 5 to at least 120 minutes, preferably from 30–75 minutes, will be required, the longer reaction times being employed with the lower temperatures and vice versa.

Although a batch process may be used for soaking the lignocellulose, it is preferred in commercial practice to carry out this operation continuously. Thus, the lignocellulose may be passed continuously by suitable conveying apparatus through a tank containing the alkaline hydroxide liquor at a rate calculated to provide the necessary retention time. Additional alkaline hydroxide is introduced into the tank as necessary to maintain the required concentration.

After the lignocellulose has passed through the tank, it may be drained on a suitable conveyor, the drainings being returned to the tank. Alternatively, the material may be passed through a screw press, squeeze rolls, or washing devices for removal of the residual liquor. The liquor thus removed may be returned to the tank, care being exercised to prevent undue liquor dilution. Such a system has the advantage of reducing chemical loss, since any liquor recovered is reusable.

The softened and wilted lignocellulose is fed, preferably metered, into a single disc (Sprout-Waldron) refiner, a double disc (Bauer) refiner, a multidisc (Reisten) refiner, rodmill, ball mill, hammermill, or other defibering apparatus, the operation of which is characterized primarily

by rubbing and crushing the lignocellulose as opposed to cutting it, thereby keeping the fiber length at a maximum value. If desired, a screw press may be used in conjunction with any of the above defibering machines ahead of the defibering elements.

For best results, the defibering consistency should be from 1–30%, preferably from 4–10%. The defibering temperature should be from 70–220° F. preferably from 170–212° F. The feed rate, refiner plate clearance and refiner plate pattern are selected so that 1 to 5 passes, preferably one pass, through the refiner will give a mechanical pulp of the desired freeness while using the maximum power of the refiner.

Maintaining a high power loading on the refiner results in a lower power consumption per ton of pulp produced. Thus the refiner plate clearance should be so adjusted that high power loading is maintained during refining, and a well-defibered pulp product is obtained at a desired freeness level.

The refined pulp resembles groundwood in many respects. It has a freeness of 5–300, preferably 50–150 cc. CSF (Canadian standard freeness) and a brightness of 30–55% GERS (General Electric recording spectrophotometer) at 460 mμ (millimicrons). It may be used directly in the manufacture of the herein described printing paper, but preferably is diluted to a consistency of from 0.5–3% and screened to remove oversize fiber particles. After screening, it may, if necessary, be diluted to about 0.5% consistency and pumped through a centrifugal cleaner for removal of any remaining dirt particles or shives. The accepted pulp may be used at once in the manufacture of paper, or it may be partially dewatered into a wet-lap and stored until used.

If it is desired to increase the pulp brightness, the pulp may be bleached easily using conventional bleaching agents in amount sufficient to attain the desired brightness value. However, it is a particular feature of the invention that the pulp may be bleached in two stages with a hydrosulfite bleaching agent to a degree of brightness which is markedly higher than that which is attained by conventional one stage hydrosulfite bleaching of lignocellulose pulps. The first of these stages occurs during the soaking of the lignocellulose with alkaline hydroxide, using part of the hydrosulfite bleaching agent. The second occurs after defibering, using the remainder of the hydrosulfite.

The hydrosulfite bleaching agent may comprise any of the alkali metal hydrosulfites, preferably sodium hydrosulfite, and/or zinc hydrosulfite. These may be used with or without various bleaching aids such as the alkali metal polyphosphates.

Although the amount of hydrosulfite bleaching agent to be used is somewhat variable, in general an overall use of from 0.2 to 5%, preferably 0.5 to 2%, of hydrosulfite, calculated as $Na_2S_2O_4$, oven dry lignocellulose basis, may be employed. From 5 to 95%, preferably 40–60% of the total amount of hydrosulfite is employed in the first or soaking stage and from 95–5%, preferably from 60–40%, by weight in the second or post defibering stage, the conditions prevailing during the second bleaching stage being substantially the same as those conventionally employed when bleaching pulps with hydrosulfite bleaching agents.

Where a chemical cellulose pulp is employed in conjunction with the pulp of the present invention, it may be derived from any species of coniferous pulpwood, such as spruce, hemlock, fir, pine and others; deciduous pulpwood such as poplar, birch, alder, gum and others; as well as from non-woody lignocellulose plant materials suitable for papermaking, such as cereal straws, bagasse, cornstalks, grasses, and the like.

These various lignocellulose materials may be converted into pulp in accordance with any of the conventional chemical pulping procedures in which lignocellulose is digested, usually under pressure, with an aqueous liquor containing the selected pulping agent. Such liquors comprise those employed in the kraft, soda, acid sulfite, neutral sulfite, chlorine-soda and other well known processes. In preparing the herein described printing paper, however, it is preferred to employ the chemical coniferous wood pulps and/or the kraft or soda non-woody lignocellulose pulps, particularly the kraft or soda bagasse and wheat straw pulps.

The foregoing chemical pulps may be employed either singly or in admixture with each other and may be subjected to preliminary treatments if desirable or necessary to improve their papermaking qualities. Thus they may be bleached to increase their brightness to a level determined by the brightness desired in the final paper product. Also they may be beaten and hydrated in commercial beaters or pulp refiners, particularly if they have been derived from wood, in order to enhance their strength and forming qualities.

In preparing the herein described papermaking furnish, the non-woody mechanical-type lignocellulose pulp prepared in the foregoing manner may, if desired, for added strength be mixed with any of the above described chemical pulps using broadly from 1–50%, by weight dry basis of the latter. The two pulps may be mixed together in a convenient manner, such as for example, by addition of lap pulp to the beater with the roll raised, or by simple fluid mixing in slush pulp aqueous systems. After a substantially uniform fibrous slurry has been produced, it is run over a conventional paper machine in the normal manner for the production of printing papers.

In typical examples illustrating the presently described procedure, a quantity of raw, non-woody lignocellulose was placed in a steam-jacketed, open kettle and the indicated quantity of alkaline liquor added. The temperature of the charge was elevated to the desired level by indirect steam heating over a 10 minute interval. At the conclusion of the reaction period, the spent alkaline liquor was drained off and the wilted and softened lignocellulose metered into a rotating disc refiner by means of a moving conveyor belt and spike-tooth feeder. Four pulp samples were thus prepared, three from substantially depithed bagasse (samples 1, 2 and 3) and one from wheat straw (sample 4). The soaking and refining conditions are summarized in Table I below:

Table I

	Sample 1 (Bagasse)	Sample 2 (Bagasse)	Sample 3 (Bagasse)	Sample 4 (Wheat Straw)
Soaking conditions:				
Alkaline liquor pH	12.7	12.7	12.5	12.5
Liquor to dry lignocellulose ratio	12.4:1	12.4:1	12.4:1	10:1
Temperature, ° F	170	212	212	212
Time at temperature, min	60	60	30	60
Sodium hydroxide consumption on oven dry lignocellulose, percent by wt	5	5	5	4
Bleaching agent present [1]	No	No	Yes	No
Refining conditions:				
Consistency, percent	8	5	8	6
Temperature, ° F	170	212	212	160
Number of passes	1	1	2	2
Test Results:				
Power usage, HP days/ton refined lignocellulose	38	37	52	20
Freeness, cc. CSF	63	41	60	136
Bursting Strength, percent	25	32	30	24
Tearing Resistance	0.58	0.62	0.58	0.54
Breaking length, meters	3,800	4,000	4,100	3,240
Apparent Density, g./cc.	0.43	0.50	0.44	0.38
Brightness, GERS at 460 mu, percent	34	38	45	38
Opacity, percent	92	92	95	94
Yield, percent on Raw lignocellulose	80	86	83	85

[1] 0.5% $Na_2S_2O_4$ and 0.25% $Na_5P_3O_{10}$ on oven dry bagasse.

The mechanical-type pulps produced by the foregoing procedures (samples 1 and 2) were similar in properties to commercial groundwood pulps. They were used in the preparation of a series of printing papers both alone and mixed with chemical-type pulps in various proportions. The compositions of the papers thus produced and their properties are indicated in Table II below, wherein the terminology is that conventional to paper testing and wherein all of the paper samples had a basis weight of 32 lbs./ream (24 x 36/500).

Depending upon the properties required in the product, the paper may be composed entirely of the herein described mechanical non-woody lignocellulose pulp, or of a mixture of that pulp with a relatively minor proportion of a chemical pulp added to increase the strength to a yet higher level without substantial impairment of the other properties of the product. Accordingly, the invention provides a means for conserving pulpwood supplies, particularly supplies of those tree species required in the manufacture of groundwood.

Table II

Standard U.S. Newsprint, Percent	100	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Mechanical-type Bagasse Pulp (Sample 1), Percent	0	100	0	0	0	0	0	0	0	0	0	90	75	0	0
Mechanical-type Bagasse Pulp (Sample 2), Percent	0	0	100	90	75	50	90	75	50	90	75	0	0	90	75
Added Chemical pulp, Percent	0	0	0	10	25	[1] 50	10	25	[2] 50	10	25	10	[3] 25	10	[4] 25
Bulk Index	96–110	110	98	96	94	88	98	96	92	96	96	105	95	96	95
Burst, Percent	22–26	25	32	26	29	38	25	28	37	27	35	32	50	28	40
Tear, g./sheet Machine Direction	15–17	15	14	17	22	28	18	22	30	19	26	20	24	26	41
Tensile, lbs./½ inch Machine Direction	4.0–4.5	3.6	3.2	3.7	3.9	4.3	3.6	3.9	4.5	4.0	4.3	4.2	6.4	4.0	4.6
Opacity, Percent	86–91	92	92	89	89	85	89	87	84	88	87	86	82	89	86

[1] Bleached kraft bagasse pulp.
[2] Bleached deciduous chemical wood pulp (Cottonwood kraft).
[3] Unbleached coniferous chemical wood pulp (hemlock sulfite).
[4] Semi-bleached kraft coniferous wood pulp.

To test further the bleachability of the bagasse pulp sample 3 (Table I) which had been soaked with alkaline hydroxide including a proportion of sodium hydrosulfite bleaching agent and thereafter defibered, was washed with water and its pH adjusted to 5.5 with acetic acid. It then was treated with further proportions of sodium hydrosulfite and the brightness of the resulting pulp determined. The results are given in Table III below:

Table III

	Sample 5	Sample 6	Sample 7	Control [6]
Pulp Brightness, GERS at 460 mu, percent	45	45	45	40
Hydrosulfite:				
Percent $Na_2S_2O_4$ used	0.5	1.0	2.0	1.5
Percent $Na_5P_3O_{10}$	1.0	1.0	1.0	1.0
Consistency, percent	5	5	5	5
Temperature, deg. F	140	140	140	140
Time, min	60	60	60	60
Brightness, GERS at 460 mu, percent	53	56	57	50

[6] Bagasse soaked 30 min. with 5% NaOH at 212° F. and defibered but not bleached.

To test the effect of incorporating the above bleached pulp in paper, the pulp designated sample 6 in Table III was mixed with bleached kraft bagasse pulp and run into paper sheets of selected compositon with the results indicated below in Table IV:

Table IV

Bleached Mechanical-type Bagasse Pulp, Percent	100	90	75	50
Bleached Kraft Bagasse Pulp, Percent	0	10	25	50
Basis Weight, 24 x 36/500	32	32	32	32
Bulk Index	94	91	88	85
Burst, Percent	30	33	37	42
Tear, g. cm./sheet	14	17	21	27
Tensile, lbs./½ in	3.3	3.7	4.1	4.5
Brightness, GERS, Percent	56	57	58	60
Opacity, Percent	93	92	90	87

Accordingly it will be apparent that by the practice of the present invention, a commercially acceptable, printing-type paper which is bleachable to a high degree of brightness may be produced without the use of the groundwood pulp normally required to provide bulk, opacity, smoothness and resiliency. Instead, a mechanically disintegrated, non-woody lignocellulose pulp is employed to provide these qualities, as well as all or most of the inherent strength of the paper.

Having thus described our invention in preferred embodiments, we claim:

1. The process of making printing paper which comprises forming a mixture of at least one non-woody lignocellulose selected from the group consisting of bagasse, straws and grasses, together with an aqueous liquor containing from 0.1 to 25% by weight of at least one member of the group consisting of the alkali metal hydroxides and the alkaline earth metal hydroxides and having a pH of at least 12, said mixture having a liquor-lignocellulose ratio, dry lignocellulose basis, of from 2:1 to 100:1; softening the lignocellulose by maintaining the mixture at a temperature of between 50° F. and 250° F. until the lignocellulose has consumed from 1 to 7% of its oven-dry weight of the hydroxide, calculated as NaOH, while retaining substantially all of its original lignin content; mechanically defibering the softened lignocellulose to form a mechanical-type papermaking pulp of high lignin content and good printing qualities; and running the pulp into paper.

2. The printing paper product of the process of claim 1.

3. The process of claim 1, wherein the non-woody lignocellulose is bagasse.

4. The process of claim 1 including the step of bleaching the non-woody lignocellulose with from 0.2 to 5% by weight of at least one bleaching agent selected from the group consisting of zinc hydrosulfite and the alkali metal hydrosulfites, dry lignocellulose basis, from 5 to 95% by weight of the total amount of the hydrosulfite being applied to the lignocellulose while treating it with the alkaline liquor and the remainder being applied to the mechanically defibered lignocellulose pulp.

5. The process of making printing paper which comprises forming a mixture of bagasse with an aqueous liquor containing from 0.1 to 25% by weight of sodium hydroxide and having a pH of at least 12, said mixture having a liquor-bagasse ratio, dry bagasse basis, of from 4:1 to 12:1; softening the bagasse by maintaining the mixture at a temperature of between 150° F. and the boiling point thereof until the bagasse has consumed from 3 to 6% of its dry weight of the hydroxide, while retaining substantially all of its original lignin content; mechanically defibering the softened bagasse to form a mechanical-type papermaking pulp of high lignin content and good printing qualities; and running the pulp into paper.

6. The printing paper product of the process of claim 5.

7. The process of claim 5 including the step of bleach-

ing the bagasse with from 0.2 to 5% by weight, dry bagasse basis of sodium hydrosulfite, from 5 to 95% by weight of the total amount of hydrosulfite being applied to the bagasse while soaking it with the sodium hydroxide, and the remainder being applied to the mechanically defibered bagasse pulp.

8. The process of making papermaking pulp which comprises forming a mixture of at least one non-woody lignocellulose selected from the group consisting of bagasse, straws and grasses, together with an aqueous liquor containing from 0.1 to 25% by weight of at least one member of the group consisting of the alkali metal hydroxides and the alkaline earth metal hydroxides and having a pH of at least 12, said mixture having a liquor-lignocellulose ratio, dry lignocellulose basis, of from 2:1 to 100:1; softening the lignocellulose by maintaining the mixture at a temperature of between 50° F. and 250° F. until the lignocellulose has consumed from 1 to 7% of its oven-dry weight of the hydroxide, calculated as NaOH, while retaining substantially all of its original lignin content; and mechanically defibering the softened lignocellulose to form a mechanical-type papermaking pulp of high lignin content and good printing qualities.

9. A sheet of pulp produced by the process of claim 8.

10. The process of claim 8 wherein the non-woody lignocellulose is bagasse.

11. The process of claim 8 including the step of bleaching the non-woody lignocellulose with from 0.2 to 5% by weight of at least one bleaching agent selected from the group consisting of zinc hydrosulfite and the alkali metal hydrosulfites, dry lignocellulose basis, from 5 to 95% by weight of the total amount of the hydrosulfite being applied to the lignocellulose while treating it with the alkaline liquor and the remainder being applied to the mechanically defibered lignocellulose pulp.

12. The process of making papermaking pulp which comprises forming a mixture of bagasse and an aqueous liquor containing from 0.1 to 25% by weight of sodium hydroxide and having a pH of at least 12, said mixture having a liquor-bagasse ratio, dry bagasse basis, of from 2:1 to 100:1; softening the bagasse by maintaining the mixture at a temperature of between 50° F. and 250° F. until the bagasse has consumed from 1 to 7% of its oven-dry weight of the hydroxide while retaining substantially all of its original lignin content; and mechanically defibering the softened bagasse to form a mechanical-type papermaking pulp of high lignin content and good printing qualities.

13. The process of making papermaking pulp which comprises forming a mixture of bagasse and an aqueous liquor containing from 0.1 to 25% by weight of sodium hydroxide and having a pH of at least 12, said mixture having a liquor-bagasse ratio, dry bagasse basis, of from 4:1 to 12:1; softening the bagasse by maintaining the mixture at a temperature of between 150° F. and the boiling point of the liquor until the bagasse has consumed from 3 to 6% of its oven-dry weight of the hydroxide, while retaining substantially all of its original lignin content; and mechanically defibering the softened bagasse to form a mechanical-type papermaking pulp of high lignin content and good printing qualities.

14. A sheet of pulp produced by the process of claim 13.

15. The process of claim 13 including the step of bleaching the bagasse with from 0.2 to 5% by weight, dry bagasse basis, of sodium hydrosulfite, from 5 to 95% by weight of the total amount of hydrosulfite being applied to the bagasse while soaking it with the NaOH liquor, and the remainder being applied to the mechanically defibered bagasse pulp.

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