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PRINTING PAPER AND PROCESS OF MAKING THE SAME

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NON-WOODY LIGNOCELLULOSE, e.g. BAGASSE

MIX WITH LIQUOR CONTAINING A WATER-SOLUBLE
INORGANIC SULFITE COMPOUND, e.g. SODIUM
SULFITE, AND HAVING A pH OF 5-11, THE
MIXTURE HAVING A LIQUOR-LIGNOCELLULOSE
RATIO OF FROM 2:1-100:1

MAINTAIN THE MIXTURE AT BETWEEN 50° AND
250° F. UNTIL THE LIGNOCELLULOSE HAS
CONSUMED FROM 0.1-4% BY WEIGHT, DRY
LIGNOCELLULOSE BASIS, OF SULFITE COMPOUND,
AND HAS BEEN SOAKED AND SOFTENED, BUT
NOT SUBSTANTIALLY DELIGNIFIED

MECHANICALLY DEFIBER THE LIGNOCELLULOSE

MECHANICAL - TYPE, NON-WOODY LIGNOCELLULOSE PULP

MIX WITH CHEMICAL PAPERMAKING PULP TO FORM
A MIXTURE CONTAINING FROM 30-90% BY WEIGHT
OF MECHANICAL-TYPE PULP

FORM MIXTURE INTO A PAPER SHEET

PRINTING PAPER PRODUCT

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3,013,931

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 paper such as newsprint and bookpaper which contain a substantial proportion of mechanical-type pulp derived from fibrous, non-woody, lignocellulose plant material, in lieu of groundwood pulp, and to a process of making such paper.

The primary prerequisites for an acceptable commercial printing paper are: a high degree of opacity so that print on one side of the paper will not be discernible from the other side; a high degree of absorbency for printing ink; sufficient bulk to receive sharp impressions of type and printing plates without blurring; adequate strength for running on high speed rotary printing machines without breaking; and pleasing general appearance for easy reading after printing.

These prerequisites are imparted to printing papers made from conventional mixtures of chemical pulp and groundwood pulp since the groundwood pulp has all of the prerequisites except strength, and the chemical pulp, being long-fibered, increases the strength of the finished sheet to the necessary level. Accordingly printing papers have long been made by blending together groundwood and chemical wood pulps in various proportions according to the properties desired in the resulting sheet.

Thus most newsprint has been manufactured from a mixture of not less than 70% by weight groundwood and up to 30% by weight of coniferous sulfite pulp or partially bleached sulfate pulp. In some instances a mixture of the latter two chemical pulps has been employed. In the United States and Canada, newsprint generally contains from 75-90% by weight of coniferous groundwood.

However, due to the continuously increasing consumption of newsprint throughout the world, efforts have been made to find a satisfactory substitute for groundwood pulp in order to prevent depletion of the forests with respect to preferred softwood species employed in the manufacture of groundwood, and thus assure the existence of an adequate newsprint supply in the future.

Hence various types of chemically digested pulps derived from non-woody lignocellulose, such as bagasse, cereal straws, and the like have been proposed for use in the manufacture of printing papers in combination with groundwood, long-fibered chemical wood pulps, or even alone. Such pulps have been produced using various conventional pulping methods, including the alkaline (sulfate or soda), acid (sulfite), neutral (sulfite), caustic soda-chlorine, and mechano-chemical processes.

Although the chemical pulps derived from non-woody lignocellulose by these processes have been found satisfactory in the manufacture of some grades of paper or board, their inherent characteristics indicate that they are unsuitable as substitutes for groundwood pulp in printing paper furnishes, mainly because of their low opacity, low ink absorbency, and low bulk. These deficiencies may be attributable to the fact that the chemical pulping agents employed react with and remove certain constituents of the lignocellulose which are responsible for the desired characteristics of groundwood.

Accordingly attempts also have been made to produce

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mechanical pulp from the non-woody lignocellulose plant materials. Thus in Vazquez, U.S. 1,688,904 a process is described wherein sugar cane is ground in the presence of water in several stages to extract sugar and produce simultaneously a pulp resembling groundwood. However, this process is applicable to sugar cane only and not to bagasse; requires fundamental revision of the conventional sugar extracting equipment and procedure; is characterized by a low production rate; requires high amounts of energy; and produces an inferior pulp of very low strength.

Asplund U.S. 2,008,892, 2,047,170 and 2,145,851 describe a process applicable to defibering non-woody lignocellulose and comprising steaming the lignocellulose under pressure at temperatures of, for example, from 300-340° F., with or without the addition of chemical pulping agents, and then mechanically defibering the steamed lignocellulose. This procedure is operated at a plasticizing temperature for lignin and alters both the lignin and hemi-cellulose content of the material so that when it is run into paper the paper is dark in color and has poor printing properties.

Similarly, Magnusson, U.S. 2,610,119 describes pre-treating lignocellulose in a solution of sulfite or other chemical at room temperature until the chemical penetrates the lignocellulose, and thereafter steaming and defibering the lignocellulose in an Asplund defibrator at elevated temperatures and pressures. Because of the severe reaction conditions employed, this process removes a substantial proportion of the content of lignin and other constituents originally present in the lignocellulose, and the constituents which remain are materially altered in their physical characteristics.

Accordingly it is the general object of the present invention to provide a printing paper having characteristics substantially equivalent to those of standard printing papers even though it is substantially devoid of groundwood pulp, and to provide a process of making such a paper.

Another object of this invention is the provision of a novel printing paper product which includes a substantial proportion of a mechanical-type pulp made from non-woody lignocellulose plant materials such as sugar cane bagasse, and of a process for making such a product.

Still another object of this invention is to provide a printing paper made from a non-woody lignocellulose pulp and characterized by superior opacity, printing qualities, bulk, and strength properties, and to provide a process for the production of such a paper.

Still another object of this invention is to provide a mechanical-type non-woody lignocellulose pulp of a character similar to conventional groundwood pulp and suitable as a substitute for groundwood in various grades of printing papers in which groundwood is usually employed, and to provide a process for the production of such a pulp.

Briefly stated we attain these objects and other advantages by providing a novel printing paper made from a mixture of chemically digested lignocellulose pulp and a mechanical-type pulp derived from non-woody lignocellulose such as sugar cane bagasse, cereal straw and the like, the mechanical-type pulp constituting from 30-90% by weight of the paper. The mechanical-type pulp is produced by first soaking the non-woody lignocellulose in an aqueous solution of a water-soluble, inorganic sulfite compound under carefully controlled conditions such that the ratio of solution to dry lignocellulose is from 2:1 to 100:1; and the soaking temperature is between 50° F. and 250° F.

The soaking time is sufficient only to permit reaction of the lignocellulose with from 0.1 to 4% of its own dry weight of the sulfite compound and hence is sufficient only to soften and wilt the lignocellulose without substan-

tially delignifying it. After the soaking operation, the lignocellulose is pulped mechanically at substantially atmospheric pressure to produce a mechanical-type, non-woody pulp which may be mixed with a chemical pulp and the mixture run into printing paper having the properties indicated above.

The chemical lignocellulose pulp which is one of the essential constituents of the fibrous furnish from which the herein described paper is made 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, jordan, and mordens, particularly if they have been derived from wood, in order to enhance their strength and forming qualities.

The non-woody mechanical-type pulp which is the second essential constituent of the fibrous furnish used in combination with the above described chemically digested pulp in making the paper product of the present invention is derived from fibrous, non-woody lignocellulose plant materials such as whole or depithed bagasse, straws, grasses and the like. A preferred mechanical-type pulp for the present purposes is that produced from substantially depithed bagasse, or from wheat straw.

As is apparent from the accompanying flow plan, in converting raw materials of the foregoing classes into mechanical type pulp by the presently described procedure, the material first is reduced to the form of small pieces, if desired, and then placed in a suitable vessel containing an aqueous solution of an inorganic water-soluble sulfite. Sulfite compounds suitable for this use include the sulfites and bisulfites of the alkali metals, particularly sodium and potassium; the sulfites and bisulfites of magnesium; ammonium sulfite; and ammonium bisulfite. In general, the sulfites have a more efficient action than do the bisulfites, although the latter may be used on lignocellulose materials which are easily softened.

The foregoing sulfite compounds may be used singly or in combination with each other, it being generally desirable to have a significant amount of sulfite present when a bisulfite is employed as the principal softening agent. They are used in amount sufficient to produce a liquor of the desired concentration, for example, one containing from 0.1 to as high as about 25%, preferably from 0.2-3% by weight of sulfite, calculated as Na_2SO_3 , as determined by such factors as the reaction time and the liquor: lignocellulose ratio.

A sufficient quantity of the foregoing liquor is employed together with the non-woody lignocellulose to furnish from 1 to about 50%, preferably from 3-6%, dry lignocellulose weight basis, of sulfite compound, the sulfite compound again being calculated as Na_2SO_3 , and to

provide a liquor: dry lignocellulose ratio of from 2:1 to 100:1, preferably from 4:1 to 12:1.

The pH of the sulfite-containing liquor also must be controlled within critical limits. In general, if the pH falls below 5, the desired softening or wilting effect of the sulfite compound on the lignocellulose does not occur. However, if the pH is permitted to rise above 11, alkaline staining of the pulp occurs. Hence the pH of the liquor should be maintained between the broad limits of pH 5-11, preferably within the restricted limits of pH 7-10. If the pH of the liquor does not inherently fall within this range, a minor proportion of an alkaline material such as the carbonates, bicarbonates, hydroxides, or oxides of sodium, potassium, ammonium and magnesium may be employed for pH adjustment. It will be understood that the amount of the alkaline compound, if used, will constitute but a small fraction of the amount of the sulfite, the latter being the essential chemical constituent of the liquor for the purpose of softening the lignocellulose.

The bagasse or other non-woody lignocellulose is treated with the 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. When the soaking is performed at ordinary room temperature, the time required may be as much as 48 hours or even more. Conversely, if a temperature of 250° F. is employed, about 5 minutes soaking time will be sufficient.

When the preferred temperature range of between 150° F. and the boiling point of the liquor is used, a soaking time of from 15-60 minutes is required. In any event the conditions of chemical concentration, liquor to lignocellulose ratio, chemical consumption, pH, temperature and time must be controlled in such a manner that the amount of sulfite actually consumed by reaction with some of the constituents of the non-woody lignocellulose during the soaking period lies within the range of from 0.1-4%, preferably from 0.4-2% based on the weight of the oven-dry lignocellulose, as determined by conventional titration procedures on liquor samples taken before and after the soaking operation. Hence substantial delignification of the lignocellulose does not occur, the lignocellulose being merely conditioned for the subsequent mechanical defibering step.

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 material is passed continuously by suitable conveying apparatus through a tank containing the sulfite liquor at a rate calculated to provide the necessary retention time. Sulfite liquor is introduced into the tank as required to maintain the required concentration.

After the material has passed through the tank, it is drained on a suitable conveyor, the drainings being returned to the tank. Alternately the material may be passed through a screw press, squeeze rolls or washing devices for removal of the residual liquor. The liquor thus removed, with or without the washings, is 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 disk (Sprout-Waldron) refiner, a double disk (Bauer) refiner, a multidisk (Reisten) refiner, rodmill, ball mill, hammermill, or other refining 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. Sufficient water may

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be supplied to the defiberizer to provide a stock consistency of from 1-25%, preferably from 4-12%. Although the temperature of the stock may vary from room temperature to about 212° F., it is preferred to maintain it in the range of between 150-190° F.

The stock is refined, recycling it if necessary, until a pulp product is obtained which has a freeness of from 30-200 cc. C.S.F., preferably between 60 and 140 cc. C.S.F. It may be used directly in the manufacture of the herein described printing paper, but preferably is diluted to a consistency of from 2-3% and screened to remove oversize fiber particles.

Also, the screened stock may 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 directly in the manufacture of paper, or it may be partially dewatered in a wet-lap and stored until used.

If it is desired to increase the pulp brightness, it may be bleached easily using conventional bleaching agents including the peroxides, the hypochlorites, or the hydrosulfites in amounts sufficient to attain the desired brightness value. The procedures conventionally employed in bleaching groundwood preferably may be used, or the bleaching agent may, if desired, be added to the stock during the defiberizing step provided a sufficient time is allowed for the bleaching action to occur, and provided the bleaching conditions are in accord with good bleaching practice.

In preparing the herein described papermaking furnish, the non-woody mechanical-type lignocellulose pulp prepared in the foregoing manner is mixed with the above described chemical pulp using broadly from 30-90% by weight dry basis of the former. When the non-woody mechanical-type pulp is mixed with a chemical pulp derived from coniferous wood, the preferred proportion of mechanical-type pulp is from 45-80% by weight. When it is mixed with a chemical pulp obtained from non-woody lignocellulose such as substantially depithed sugar cane bagasse or cereal straw the preferred proportion is 40-75% by weight. The mechanical-type and chemical 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.

The invention is illustrated by the following examples wherein Examples 1-6 inclusive illustrate the presently described procedure for manufacturing a pulp product from bagasse and other non-woody lignocellulose, and Examples 7-16 inclusive illustrate paper products prepared from such pulps.

EXAMPLE 1

500 pounds of depithed bagasse was charged into a steam-jacketed, open top tank together with an aqueous liquor containing sodium sulfite and sodium tripolyphosphate (to prevent iron contamination) in amount sufficient to give a mixture having a liquor to oven-dry bagasse ratio of 10:1. The amount of sodium sulfite was 3% and the amount of sodium tripolyphosphate 0.2%, based on the weight of the oven-dry bagasse. Thus the sodium sulfite concentration in the liquor was 0.3% by weight. The initial liquor pH was 9.3.

The shell steam was turned on to raise the temperature of the mixture to 200° F. over a period of 10 minutes. The mixture was maintained at this temperature for 15 minutes. The softened bagasse then was separated by draining for 5 minutes. The pH value of the resulting liquor was 7.6, and the amount of sodium sulfite consumed was 0.42% of the dry lignocellulose weight.

The bagasse then was washed with fresh hot water

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and metered into a double-disc Bauer refiner at a plate clearance of 0.05 inch. Sufficient spray water was added to the refiner to provide and maintain a 9% stock consistency. The stock was defibered at atmospheric pressure and 190° F. after which it was discharged from the refiner, diluted with water to a 3% consistency, dewatered to a consistency of 12% in a conventional decker, and passed again through the refiner. This cycle was repeated 6 times.

The resulting pulp had a freeness of 60 cc. C.S.F. contained substantially the same proportion of lignin as the original raw bagasse, had a brightness of 50% G.E.R.S., and resembled conventional groundwood pulp. The pulp yield was 90% of the original oven dry weight of the bagasse.

The mechanical-type pulp thus produced was bleached readily with 1.5% sodium hydrosulfite and 1% sodium tripolyphosphate, both based on the oven dry weight of the pulp, to a brightness of 62% G.E.R.S.

The bleached pulp was screened at 2% consistency in an Impco rotary screen having 0.045 inch perforations. The rejected screen stock was pumped back to the defiberizing system; the accepted screen stock was diluted to a consistency of 0.5% and pumped through a Bauer Centricleaner at 50 p.s.i.g. after which it was wet-lapped on a wet machine.

The properties of the mechanical-type bagasse pulp thus obtained are given in Table I.

Table I

	After defiberizing	After bleaching and centrifuging
Freeness, cc. C.S.F.....	60	40
Bursting strength, percent.....	13.4	19
Tearing resistance.....	40	50
Breaking length, meters.....	1,730	2,580
Apparent density.....	0.34	0.37
Opacity, percent.....	97.5	98.2
Brightness, percent G.E.R.S.....	50	62

The pulp product was well suited for making printing paper since it had higher opacity than conventional groundwood and was further characterized by excellent ink absorbency, smoothness and softness.

To the contrary, attempts to produce a satisfactory printing paper by mechanically defiberizing non-woody lignocellulose such as bagasse (1) with no preliminary soaking at all and (2) with soaking in water only have been unsuccessful. In both cases, the lignocellulose was disintegrated by defiberizing to a chunky mass resembling fine sawdust and having extremely low strength properties. Accordingly it was entirely unsatisfactory for use in the manufacture of printing paper.

EXAMPLE 2

Following the general procedure of Example 1, bagasse was soaked at 200° F. for 60 minutes in an aqueous liquor containing 5% sodium sulfite and 0.2% sodium tripolyphosphate, based on the weight of the oven dry bagasse, the liquor to oven dry bagasse ratio being 10:1 and the sodium sulfite concentration 0.5% by weight. The initial pH of the liquor was 9.4 and its pH after soaking the bagasse was 7.0. The amount of sodium sulfite consumed was 0.97%, based on the oven dry weight of the lignocellulose.

The softened bagasse was separated, washed with hot water and defibered to a freeness of 60 cc. C.S.F. with the Bauer refiner plate setting, initially 0.05 inch, being reduced to 0.03 inch after the stock had passed through the refiner a few times.

After screening and centricleaning the pulp, its properties were as follows:

Table II

	After de-fibering	After centricleaning
Freeness, cc. C.S.F.....	60	35
Bursting strength, percent.....	10	15
Tearing resistance.....	30	39
Breaking length, meters.....	1,230	2,280
Apparent density.....	0.36	0.39
Opacity, percent.....	97.8	98.2
Brightness, percent G.E.R.S.....	49.5	49.5

The pulp product had an opacity higher than standard ground wood and was suitable for making printing-grade papers when admixed with a minor proportion of chemical pulp.

EXAMPLE 3

Bagasse was soaked at 190° F. for 60 minutes in an aqueous liquor containing sodium sulfite and sodium triphosphate in amounts of 3% and 0.2% respectively, based on the dry weight of bagasse. The liquor to dry bagasse ratio was 12:1, and the liquor concentration was 0.25% of Na₂SO₃ by weight. The initial and final pH values of the liquor were 9.3 and 7.4 respectively. The amount of sodium sulfite consumed during soaking was 0.46%, based on the dry weight of the bagasse.

The soaked and softened bagasse was drained for 5 minutes and then metered into a 24-inch, single-disc Sprout-Waldron refiner, in which the plate clearance was adjusted initially to 0.03 inch, and reduced in subsequent defibering treatments to 0.02 inch. The bagasse was refined at an 8.5% consistency until a pulp having a freeness of 180 cc. C.S.F. was obtained. After screening, centricleaning and bleaching as in Example 1, the pulp product had excellent printing qualities and was very well suited for use as the main constituent of a newsprint furnish. Its properties are given in Table III.

Table III

	After de-fibering	After bleaching and centricleaning
Freeness, cc. C.S.F.....	180	121
Bursting strength, percent.....	8	14
Tearing resistance.....	41	51
Breaking length, meters.....	1,340	2,010
Apparent density.....	0.33	0.33
Opacity, percent.....	95.0	97.3
Brightness, percent G.E.R.S.....	49.5	61

EXAMPLE 4

The procedure described in Example 1 was followed using wheat straw in lieu of bagasse.

Wheat straw was chopped in a hammer mill to a length of about 2 inches, and soaked at 200–212° F. for 1 hour in an aqueous liquor containing 5% sodium sulfite based on the dry weight of the straw. The liquor to dry straw ratio was 10:1. The soaking liquor was drained from the straw. The soaked material was metered into a Bauer disc refiner and refined at 8% consistency at 200° F. until it had reached a freeness of 135 cc. C.S.F.

After screening and centricleaning, the resulting pulp had very satisfactory printing qualities and was well suited for use as a substitute for groundwood pulp in the manufacture of printing papers. Its physical properties are shown in Table IV.

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Table IV

	After de-fibering	After centricleaning
Freeness, cc. C.S.F.....	135	90
Bursting strength, percent.....	12	21
Tearing resistance.....	44	38
Breaking length, meters.....	1,360	2,890
Apparent density.....	0.35	0.46
Opacity, percent.....	97.6	97.8

EXAMPLE 5

Bagasse was soaked at 212° F. for 60 minutes in an aqueous liquor containing ammonium sulfite in the amount of 5% based on the weight of oven dried bagasse, the liquor to oven dry bagasse ratio being 12.4:1. The initial pH of the liquor was 8.0 and its pH after soaking the bagasse was 7.0.

The softened bagasse was allowed to drain thoroughly and then metered into a 24 inch single disc refiner in which the plate clearance was adjusted initially to 0.01 inch and reduced in subsequent defibering treatments to the lowest possible value. The defibering cycle was repeated several times at 8% stock consistency until a pulp having 100 cc. Canadian Standard Freeness was obtained. The defibered pulp then was screened and centricleaned. Its properties are shown in Table V.

Table V

	After de-fibering	After centricleaning
Freeness, cc. C.S.F.....	75	37
Bursting strength, percent.....	2	12
Tearing resistance.....	10	21
Breaking length, meters.....	809	2,285
Apparent density.....	0.313	0.395
Opacity, percent.....	98.8	98.6
Brightness, percent G.E.R.S.....	47.5	48.5

EXAMPLE 6

Bagasse was soaked at 212° F. for 60 minutes in an aqueous liquor containing 4% magnesium sulfite, oven dry basis. The liquor to oven dry bagasse ratio was 12.4:1. Magnesium oxide was added so that the initial pH of the liquor, prior to addition of the bagasse, was 9.7.

After the above treatment, the residual liquor had a pH of 6.7. The softened, drained bagasse was metered into a 24 inch single disc refiner. Plate clearance on the initial pass was 0.007 inch; for subsequent passes the clearance was reduced to 0. The defibering cycle was repeated five times at 8% consistency until a pulp having a C.S.F. of 80 cc. was obtained. The defibered pulp was then screened and centricleaned in the manner described in Example 1. The properties of this pulp are shown in Table VI.

Table VI

	After de-fibering	After centricleaning
Freeness, cc. C.S.F.....	82	15
Bursting strength, percent.....	1.2	11.4
Tearing resistance.....	18	21
Breaking length, meters.....	615	2,150
Apparent density.....	0.35	0.42
Opacity, percent.....	99	99
Brightness, percent G.E.R.S.....	48.5	48.8

EXAMPLE 7

This example illustrates a sheet of newsprint composed of 50% chemical bagasse pulp and 50% mechanical-type bagasse pulp, prepared in a manner similar to that outlined in the preceding examples.

The chemical pulp was produced by digesting depithed bagasse with a kraft liquor containing 12% active alkali (calculated as Na₂O) for 20 minutes at 340° F., with an initial period of 60 minutes needed to raise the tempera-

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ture of the charge to 340° F., the liquor to dry bagasse ratio being 5:1. The resultant pulp was washed and screened in a conventional manner, and then bleached in a single hypochlorite stage to 60% G.E.R.S. brightness.

The mechanical-type pulp was produced by the method set forth in Example 1.

Both pulps were thoroughly mixed together in substantially equal proportions. Aluminum sulfate was added to the pulp slurry to adjust its pH to 5, and the pulp was run on a commercial Fourdrinier paper machine at a speed of 1500 feet/minute, with no operational difficulties.

The properties of the newsprint thus produced are given in Table VII together with the properties of conventional newsprint made in the United States from 80% coniferous groundwood and 20% coniferous sulfite pulp.

Table VII

	Bagasse Newsprint	Conventional Newsprint
Moisture content, percent.....	6.9	7.0
Basis weight, lbs./ream.....	31.7	32.0
Bulk index.....	98	106-110
Bursting strength, percent.....	36	22-26
Tearing resistance:		
M.D. ¹	23	15-17
C.D. ²	26	20-23
Tensile strength, lbs., M.D.....	4.9	4.0-4.5
Dirt count.....	20	40
Opacity, percent.....	91	86-91
Brightness, percent G.E.R.S.....	57.5	54-58

¹ Machine direction.

² Cross machine direction.

The above described bagasse newsprint was run on a double-unit commercial newsprint printing press at a speed of 45,000 signatures per hour, the normal operating speed for regular newsprint being 38,000 signatures per hour. No operational difficulties were experienced, and the printing qualities of the paper were excellent.

Thus the properties and performance of the newsprint of this invention were at least equivalent, and in many respects superior, to those of conventional newsprint made from a mixture of groundwood and chemical pulp.

EXAMPLES 8-10

These examples illustrate printing papers produced on a Fourdrinier paper machine from the same pulps as described in Example 7, but employed in different proportions.

The respective fibrous furnishes and the properties of the resulting papers are shown in Table VIII.

Table VIII

	Ex. 8	Ex. 9	Ex. 10
Chemical bagasse pulp, percent.....	70	25	15
Mechanical-type bagasse pulp, percent.....	30	75	85
Basis weight, lbs./ream.....	32	32	32
Bulk index.....	95	101	108
Bursting strength, percent.....	30	29	21
Tearing resistance:			
M.D.....	26	18	15
C.D.....	31	23	19
Tensile strength, lbs., M.D.....	7.8	4.7	4.0
Opacity, percent.....	86	92	93.5
Brightness, percent G.E.R.S.....	56.5	57.8	58.1

The printing qualities as well as bulk, opacity, and strength properties of these printing papers were entirely satisfactory even though neither groundwood nor strong coniferous chemical pulp was employed in the fibrous furnishes.

EXAMPLES 11-14

These examples illustrate the printing papers of this invention produced on a Fourdrinier paper machine from mixtures of chemical pulps obtained from coniferous woods, and mechanical-type bagasse pulp. The chemical pulp employed was commercial unbleached sulfite pulp

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derived from western hemlock, having a brightness of 59% G.E.R.S., and commercial semi-bleached kraft pulp derived from Douglas fir and having a brightness of 62% G.E.R.S. The mechanical-type pulp was produced in the manner described in Example 1.

The respective fibrous furnishes and the properties of the resulting papers are given in Table IX.

Table IX

	Ex. 11 Sulfite	Ex. 12 Sulfite	Ex. 13 Kraft	Ex. 14 Kraft
Chemical wood pulp, percent.....	15	60	10	50
Mechanical-type bagasse pulp, percent.....	85	40	90	50
Basis weight, lbs./ream.....	31.5	31.8	32.8	31.2
Bulk index.....	104	95	109	96
Bursting strength, percent.....	22	36	19	58
Tear resistance:				
M.D.....	16	21	16	23
C.D.....	20	28	21	42
Tensile strength, lbs. M.D.....	4.2	5.7	4.1	9.8
Opacity, percent.....	93	88	93.8	88
Brightness, percent G.E.R.S.....	58	57.3	58.2	58.2

The printing qualities, bulk, opacity, and strength characteristics of the above papers were very satisfactory for use in modern, high-speed printing presses.

EXAMPLE 15

This example illustrates a printing paper formed from a mixture of 25% chemical wood pulp, i.e. commercial unbleached western hemlock sulfite pulp having a brightness of 59% G.E.R.S.; and 75% mechanical-type non-woody lignocellulose pulp, i.e. wheat straw pulp prepared by the method of Example 4.

The properties of printing paper made on a conventional Fourdrinier paper machine from the above mixture are shown in Table X.

Table X

	Printing paper
Basis weight, lbs./ream.....	32
Bulk index.....	98
Bursting strength, percent.....	27
Tearing resistance:	
M.D.....	19
C.D.....	25
Tensile strength, lbs., M.D.....	5
Opacity, percent.....	91
Brightness, percent, G.E.R.S.....	57

It is evident from the above data that a satisfactory printing paper was produced from another type of non-woody lignocellulose, namely straw, converted to a mechanical-type pulp and admixed with commercial coniferous sulfite pulp.

EXAMPLE 16

This example illustrates a printing paper produced on a Fourdrinier paper machine from a fibrous mixture consisting of 40% by weight of commercial chemical wood pulp derived from pulping a deciduous species, southern gum, by the kraft process, and semi-bleached to 63% G.E.R.S. brightness; and 60% by weight of a mechanical-type bagasse pulp produced in the manner described in Example 1.

The properties of the resulting paper are shown in Table XI.

Table IX

	Printing paper
Basis weight, lbs./ream.....	31
Bulk index.....	97
Bursting strength, percent.....	34
Tearing resistance:	
M.D.....	22
C.D.....	25
Tensile strength, lbs., M.D.....	4.7
Opacity, percent.....	91
Brightness, percent, G.E.R.S.....	58.5

The printing properties and other physical characteristics were very satisfactory and comparable to those of normal printing papers comprising a substantial proportion of groundwood pulp in the furnish.

Thus it will be apparent that by the present invention we have provided a process for preparing a mechanical-type pulp from non-woody lignocellulose such as sugar cane bagasse and straw. A mixture of this pulp with a limited proportion of chemical pulp may be run into a printing paper having satisfactory properties even though it is devoid of groundwood pulp. This novel paper product may be prepared from low cost starting materials using conventional papermaking equipment. Also, since the necessity of using groundwood is eliminated, application of the herein described papermaking process serves as an important conservation measure in that it reduces the demands on available supplies of standing softwood timber of the classes conventionally used in the production of groundwood.

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 a water-soluble inorganic sulfite compound and having a pH of 5 to 11, 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 0.1 to 4% of its oven-dry weight of the sulfite compound 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; forming a pulp mixture comprising a chemical papermaking pulp and from 30 to 90% by weight, dry weight basis, of said mechanical-type papermaking pulp; and running the pulp mixture into paper.

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

3. The process of claim 1 wherein the non-woody lignocellulose comprises bagasse and the water soluble inorganic sulfite compound comprises a sulfite compound of sodium.

4. The process of making printing paper which comprises forming a mixture of bagasse and an aqueous liquor containing from 0.2 to 3% by weight of a water-soluble inorganic sulfite compound of sodium and having a pH of 7 to 10, 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 0.4 to 2% of its oven-dry weight of the sulfite compound 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; forming a pulp mixture comprising a chemical papermaking pulp and from 30 to 90% by weight, dry weight basis, of said mechanical-type papermaking pulp; and running the pulp mixture into paper.

5. The printing paper product of the process of claim 4.

6. 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 a water-soluble inorganic sulfite compound and having a pH of 5 to 11, 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 0.1 to 4% of its oven-dry weight of the sulfite compound 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.

7. A sheet of pulp produced by the process of claim 6.

8. The process of claim 6 wherein the non-woody lignocellulose comprises bagasse.

9. The process of claim 6 wherein the non-woody lignocellulose comprises straw.

10. The process of claim 6 wherein the water-soluble inorganic sulfite compound comprises a sulfite compound of sodium.

11. The process of claim 6 wherein the mixture of non-woody lignocellulose and liquor is maintained at a temperature of between 150° F. and the boiling point of the liquor.

12. The process of making papermaking pulp which comprises forming a mixture of bagasse and an aqueous liquor containing from 0.2 to 3% by weight of a water-soluble inorganic sulfite compound of sodium and having a pH of 7 to 10, 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 0.4 to 2% of its oven-dry weight of the sulfite compound 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. A sheet of pulp made by the process of claim 12.

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