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The Influence of Pith Cells on the Papermaking Characteristics of Pulp from Bagasse

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Literature Survey

Introduction

The fact that the need for paper products is increasing in an unparallel manner with the wood resources available at the United States market, has open the field for research studies in the development of new raw materials.

Bagasse has been a waste product submitted to intense laboratory investigation due to the fact that is a world available and relatively cheap fiber. Its use as a papermaking material has been investigated over a 100 years. Its development has been attacked by the differents and contradictory opinions obtained from pilot plant runs and lack of knowledge techniques in the handling and treatment of bagasse for pulping purposes.(18)

The purpose of this work is to disclose the must progresive reports and achievements in the production of paper products from sugarcane bagasse, as well as to learn the true facts about the effect of the pith cells in the paper characteristics for its controversial situation.

Origin of Bagasse

Bagasse is an agricultural residue from the sugar-cane obtained as a waste product in the sugar industry.

Bagasse is still largely used as fuel in the sugar mills. With the increased heat economy in the sugar house, most mills do not require as fuel all the bagasse as a disposal measure.(19) Bagasse is otherwise used for the manufacture of insulating building board products in the United States, Hawaii and Australia; for making paper in Peru, the Philippine Islands, and India; for making plastics, and as chicken litter, mulch and an absorbent for molasses in Louisiana. But from the over-all standpoint, the amounts of bagasse so used are negligible, and when so used the profit to the sugar mills is about $.50 per dry ton above its fuel value.

Properties of Bagasse

The proximate chemical analyses of three samples of bagasse are presented in table 1. In reviewing the data it will be noted that the percentage of water-soluble materials in the whole bagasse in samples nos. 2 and 3 is much higher than on the respective pith and fiber fractions of the two samples. As noted in table 1, the pith and fiber fractions of all three samples were obtained by fractionation in water. The samples of fresh whole bagasse nos. 2 and 3 contained more water-soluble material than the stored bagasse (no.1), such material having been destroyed to a considerable extent by fermentation during storage. The pith fractions contain more soluble material and more ash than the fiber fractions. This is due to the greater surface area in the pith on which impurities can be absorbed as compared whith that in the

TABLE 1*

PROXIMATE ANALYSIS OF SUGARCANE BAGASSE (19)

	No. 1 Lockport, Louisiana Stored 1941			No. 2 Houma, Louisiana Freshly dried 1941			No. 3 Clewiston, Florida Freshly Dried 1948		
	Whole Bagasse %	Pith %	Fiber %	Whole Bagasse %	Pith %	Fiber %	Bagasse %	Pith %	Fiber %
Moisture	4.1	12.2	6.8	4.9	8.7	9.7	7.3	8.9	7.2
Ash	2.9	4.6	2.0	2.4	6.3	2.2	2.2	3.4	2.0
Extra ctives Alcohol-benzene	1.7	1.7	1.6	6.0	2.9	2.0	3.5	2.5	2.6
Hot Water	4.0	3.1	2.4	8.8	3.4	3.4	11.2	4.6	4.5
1% NaOH	32.9	36.1	28.4	35.9	36.2	30.5	39.9	35.0	31.2
Lignin	21.3	21.3	20.7	18.9	18.0	19.9	18.1	18.2	19.1
Pentosans	29.4	31.3	30.6	30.0	32.9	32.7	28.5	32.6	31.7
C & B cellulose	58.4	54.6	61.4	53.3	52.2	59.0	52.0	58.2	61.4
Pentosans in C & B cellulose	29.3	30.3	31.7	27.9	28.7	29.6	26.9	29.1	29.8
Alpha in C & B cellulose	67.1	62.8	70.0	67.3	62.4	67.7	68.1	61.3	64.4
Alpha basis original	39.2	34.3	43.0	35.9	32.8	39.9	35.4	35.7	40.1
Pentosans in Alpha	6.1	5.7	10.0	7.0	6.6	8.1	4.7	5.0	4.6

* All values except moisture based on oven-dried material.

fiber. The other outstanding difference between the composition of pith and fiber is the lower cellulose content of the pith.

During commercial storage as practiced at Lockport or Terrebonne, Louisiana, about 10 percent of bagasse is destroyed by fermentation. From the above data it would appear that this fermentation has destroyed pith and fiber about equally, since there is little difference in the proximate analytical values for pith or fiber between stored and fresh bagasse from Louisiana. It seems evident, in comparing Florida and Louisiana samples, that cane variety is more important in affecting chemical composition.

Utilization of bagasse in Papermaking

(A) Historical Review

The idea of using sugar cane bagasse as a raw material is nothing new to the pulp and paper industry.(2) The thought has crossed men's minds whenever fiber shortages have occurred during the past 100 years. A tremendous amount of experimental work has been carried out, hundreds of patents have been granted on process for its utilization, and hundreds of articles have been published the world over. One process dates as far back as 1838.

Many of the reports have come from reliable and serious investigations with a thorough understanding of principles involved. These have appeared in the technical journals and have contributed worthwile knowledge toward scientific progress in the field. On the other hand many other reports, notably those involving fanfare and publicity, have emanated from promotors with complete lack of knowledge in the field. Activities of these group through the years have been highly detrimental to progress toward large scale commercial use of bagasse for production of pulp and paper.

Unfortunately, in almost all of the commercial ventures in this field until about 1939, attempts have been made to produce salable paper.

Only those which involve the production of wall board or low quality paper and paper board have survived.

The date of the first reported commercial use of bagasse of paper stock is about 1844, when some bagasse was shipped to France from the Island of Martinique, although on proposed process for its use dates back to 1838. Paper from bagasse was considered to have some value by that time, because patents for certain papermaking process, mention bagasse among the raw materials.

Much bagasse was shipped to Northern Mills where experiments were carried on for the manufacture of paper. Mills were projected in 1880 for Milford, Pa. on the Bajou-Teche, La., and at Cape May, N.J., in 1881. In July 1887, the local Ottawa, Kansas, published, "Otawwa is to bear off the honors of having the first mills in the State to make white paper. Bagasse is to be used as raw material. "

In 1882 the Louisiana Fibre Working Co. was organized and built a mill in which many unsuccessful attempts, over a period of five years, were made to make paper from bagasse.

From 1903 to 1905, Viggo Drewsen of New York carried out an extensive series of experiments on bagasse at the mills of the S.D. Warren Co. Cumberland Mills, Maine. As a result of these experiments, Drewsen was granted a number of patents. He succeded in producing a good grade of paper, but this process required from three to four tons of bagasse to make one ton of paper. Furthermore the expense of bleaching was so great that nothing has ever been done with this process.

In 1920, the Celotex Corp. had its beginnings in Marrero, La. This company was the first to produce successfully and commercially products manufactured from bagasse, and it has steadily expanded until its operations are now very extensive, producing

large quantites of building board, insulating, acoustic material, etc. which is marketed in practically every country in the world.

In 1928, a mill was to produce 40 tons of dissolving pulp per day by the de la Roza process. Many economic advantages were claimed and the mill was to be enlarged to a capacity by 120 tons a day. It was reported by de la Roza to be producing a high grade of Alpha cellulose adapted for manufacture of rayon and similar high quality products and high grade paper. It has been claimed by de la Roza that 1929 depression through them out of bussiness.

(B) Successful use during the past fifteen-years

1- In 1939 Pilot Plant of Cellulose Development Corp.in England, St. Pauls Cray, Kent, England improved and made a commercial success of the Celdecor-Pomilio continous process. They produced 5 tons bleached pulp per day from straw, bagasse and other fibers.

2- The Envisko Pulp Co. at hsinying Taiwan (1940) was producing 100 tons of bagasse pulp per 24 hours. The second World War put them out of bussiness. The mill started again (Hsinying Mill) in 1947 discarded the Magnesium base acid sulphite process formerly used and adopted the monosulphite process with small concentration of caustic soda as buffer. A great variety of papers are being produced using rather high proportion of the bagasse pulp.

3- At Bais Central, island of Oriental Negroes,Phillipines, the Cia. of Cellulosa de Filipinas was operating a bagasse mill before Japanesse invasion. About 1500 tons bank-notes and bond papers, 90 % or more of bleached pulp were produced.

This mill was reopened in 1949 producing 15 tons per day of banks and bond which normally contains 95% bagasse fiber and 5% imported wood pulp. They use a dry method of separating

pith from fiber and return the pith to the boiler plant. The fiber is then cooked and bleached by Celdecor-Pomilio soda-clorine process. The bleached pulp is converted into white light weight bonds and writing papers on a 92 inches Pusey and Jones Paper Machine. The yield on cleaned dry bagasse is 45 to 50%; a typical evaluation of 95% bagasse is given below.(3)

Strength of 15 3/4 D. C. Bank Paper

Furnish 95% bagasse, 5% Wood Pulp

Substance lbs. D. C. 480's	.... 15 3/4
Basic weights gm/m W	.... 58.1
Thickness, ins. /1000	.... 3.13
Bulk Factor, ccs/gm	.... 1.37
Burst lbs./ $in.^2$ (Schopper Dalen)	.... 24.0
Burst Factor, gms./$cm.^2$ /W	.... 29.1
Tear Factor, gms./ W (Marx Elmendorf)	
Machine Direction	 41
Cross Direction	 50
Breaking Length, metres	
Machine Direction	 5300
Cross Direction	 3010
Stretch % 9cm. length	
Machine Direction	.... 1.8
Cros Direction	.... 1.5
Ash % on Air Dry Paper	.... 2.0

The strength is equivalent to that of similar wood free papers.

4- At Paramonga, Peru W.R. Grace Co. started a plant 1939 blending bagasse with various grades of wood pulps. A great variety of papers and boards were produced. The total output in 1940 was 3,000 tons papers, and in 1951 was 19,000 tons papers. Actually bagasse accounts for 70% of total processed.(4)

This mill has been produced grocery bags, cigaretts packages and candy wrappers, carboards, cartons, copy paper, newsprint and blue paper for wrapping cotton.

Newsprint and printing papers are 100% semi-bleached bagasse pulp. Paper boards 60 to 80%, others from 45% multi wall kraft bag paper up to 75 to 85% in sulphite wrapping. At present the pulp is used in the production of coloured sulphite wrappings, newsprint and printing papers.

An outline of the process is; first, washing and screening to remove pithy materials; second, cooking for the time required to produced distinct paper types; third, refining to the degree most suited for the production of the various grades. The method was developed from tests under the direction of Mr. G. J. Lipscomb. A mechanical system for pith-separation is utilised to remove up to 35% of the pith cells before the accepted fibre is baled for storage.

After the baled bagasse has been stored for several months it is processed by standard methods in rotary digesters, blow tank vacuum washers, screens and thickeners. The fibre is digested by a modified soda process, amounts of chemicals varying with the grade of pulp.

For pulp beating and refining standard equiptment is used (beaters and jordans). Care upon attaining the correct degree of refining as to combine the factors of strength and freeness must be taken and thus give strong papers at as minimum sacrifice in machine speed.

There are two machines, one having a combination wet-end (fourdrinier and cylinder) combination and triming 100 inches, and the other a fourdrinier tissue machine with yankee triming 72 in.

Operating speeds on the large machine vary from 80f.p.m. on the heavier boards to 650 f.p.m. on wrapping papers. Pulps from

sugar cane bagasse are somewhat slower on the machine than wood pulp fibers so that, unless properly handled, top speeds cannot be obtained.

5- A mill for making low quality pulp and paper from bagasse has operated at Villa Ocampo, Santa Fe, Argentina since 1943, 25 tons per day of paper were produced.

6- At Colombia the Container Corp. of America Mill at Cali, Valle del Cauca has been producing 15 tons per day of bagasse pulp. This pulp is moved with waste paper and wood pulp from manufacture of various grades of paper-boards.

7- Compania Celulosica y Papelera del Norte, S.A. in Cayalti, Peru started early in 1952. Twenty-five tons per day of various grades of wrapping papers in colors are produced.

8- Rothas Industries ltd. Dalmianagar, Bihar, India have operated since 1951. The mill produced 20 tons bleached per day. The pulp is with bamboo for white surface in duplex and triplex board, playing cards, fine art boards and cigaretts cartons.(5)

The process used is as follows: The bales are broken down in specially design desintegrators and the unwanted material removed. The good fiber goes to be soaked with caustic soda of appropiate strength. After continous passage through Celdecor digestion tower, heated by steam jackets, and continously extracted from the digestion unit, the pulp is washed in two stages, subejected to mechanical treatment and partially dried before chlorination effected in a patent continously operated tower. The chloro-lignin formed is washed put with weak alkaline solution followed by rough and fine screening in three stages by Celdecor- Kamyr flat and rotary screens. The bleaching in one hypochlorite stage.

9- Sao Paulo, Brazil, at Refinados Paulista, S. A. a continous Celdecor-Pomilio process is used producing 25 tons per day.

The reasons for failure of previous commercial attemps to

utilize bagasse have been overcome. The structure of the bagasse is now well known; uses have been developed for the pith;pith-free fiber is available excellent methods of storage have been worked out,there is high degree of understanding of the type of pulp and paper products which can be produced from the bagasse fiber. All depends upon the economic factors and availability of markets.

C- Projected Mills

Among the countries interested in producing paper products from bagasse are: Egypt, Argentina, Puerto Rico, Hawaii, Louisiana, cuba, Mexico, South Africa, Jamaica, and Dominican Republic. Recent publication have revealed plans for the construction of bagasse mi mills.

1- De La Roza Corp. has planned to build a plant at Clewston, Florida. Production would be 150 to 175 tons daily of newsprint.(6)

At present Mr. De La Roza is in Cuba studying the plans for the construction of a bagasse pulp plant, for the Cuban government.

2- Another bagasse newsprint mill is being planned,by the Brown and Root Inc., Houston, for the Valite Corp., New Orleans,La. 17,250 tons annually of paper and dissolving pulps are the plans for production. They claim the Valite process can also produce book, bond, coated and other types of whites and cellulose pro - ducts from pith containing whole bagasse.(7)

3- At the Dominican Republic will also be build a bagasse newsprint and paper plant. They calculate the production to be 8,500 tons per year.(8)

Methods of Pulping Bagasse

The following are a number of processes either succesfully used in commercial operation of those whose success seems assured as a result of large test runned.

(a) Chemical Methods

1- Soda Process (9)

The basic soda process involves cooking the bagasse fiber under pressure in rotary or stationary digesters, using caustic soda as the active cooking chemical. In cooking bagasse chemical use might vary from 8 to 16 per cent caustic soda,based in the dry weight of the fiber. This depends upon the quality of the product, wether or not recovery system is used, and the importance of chemical cost, as compared to cost of equipment,steam, power and labor. The time of cooking varies from one to five hours and preassure vary from atmosphere to 100 pounds per square inch.

A slight modification of the batch type soda process has been used very succesfully by W. R. Grace Co. in Peru. They use a small amount of sulfu along with caustic soda, thus gaining some of the advantage of the sulfate process.

2- The Sodium Monosulphite or Neutral Sulphite Process.

The basic chemicals are sodium monosulphite (Na_2SO_3) and caustic soda cooking time varies from 2 to 8 hours, cooking pressures varies from 50 to 100 pounds per square inches, and liquor ratio varies from 4 to 1 or 7 to 1.

The Northern Regional Research at Peoria, Ill.,has conducted rather extensive experimental work on a modification of this process. The monosulphite process yields amout 56 to 58 per cent from depithed fiber. The chemical requirements are half or less than those required by soft wood and hard wood for fine pulps production. Bursting and tensile strength of monosulphite bagasse pulps are in the same range as those of sulfite soft wood pulp.

Bagasse pulp by these process continues 3 to 5 per cent lignin and requires 5 to 7 per cent total chlorine to reach a brightness of 70

3- Celdecor-Pomilio Process

This is a variarion of soda process; developed in Italy and improved by Cellulose Development Corp., England. Chemical costs are high, unless low cost salt and low cost power are available. This process has been operated successfully for years in various mills in India, Philippenes and Brazil.

4- De La Roza Process (17)

The raw bagasse is "dusted" to remove gross dirt. The weight loss for this operation is placed at 10 perdent. The rotary digestor is charged and a steam prehydrolisis is performed. The unit is drained. This is followed by a Kraft digestion in the same unit. The crude pulp is drained and stored in the chest of the paper machine where it is washed. The pulp is tranferred to the beater where it is bleached with calcium hypochlorite, thoroughly washed, the furnish added and adjusted respecting pH, and the paper made.

The process involves nothing in equipment or chemicals used which would present unusual problems in commercial operation. No process difficulties are observed at any time. From raw bagasse to finished paper, the evidence leads to the conclusion that the procedure can be duplicated in commercial equipment and essentially the same product obtained.

5- Valite Process (17)

The raw bagasse is dusted to remove gross dirt. The rotary digestor is charged and a short prehydrolysis provided. Besides heat, the prehydrolysis involve the use of a chemical, the identity of which os not here disclosed. The chemical offers no recognizable problem in use or effect on equipment and constitues no significant part of operations costs. The pulp is then drained and thoroughly washed with water.

The digester is charged and the alkaline liquids ad - mitted under closely controlled conditions. The details of this operation are not revealed here. It can be reported that the chemical costs are comparable to those for caustic; the controlled addition offers no problems in execution and involves only a negligible expense.

The pulp is then dumped, drained, thoroughly, washed, and chlorinated in the closed system. A caustic extraction and hypochlorite bleach followed. The furnish was added in the Jordan and the paper then made.

The process involves no equipment of an impractical nature and no expensive chemicals. Experience indicates that desired results are not readily reproducible with certainty. This may be due to a high degree of sensitivity, to minor variations in process, or to the fact that bagasse change in characteristics.

6- Chemcel Process -- owned by Kinsley Chemical Corp.(17)

Raw bagasse as received is used without dusting. This is charged into the rotary digester and a mild Kraft digestion follows. The chemicals required are caustic and K chemicals, a propietary product offered for sale by the company for this purpose. The composition of K chemicals is not revealed here. They are, however, commonplace chemicals, being neither rare, costly, nor unusual.

After draining, the pulp is washed for 4 hours and them stored. Chlorination is effected in the closed system and the pulp then neutralized and washed. The furnish is added in the beater and the paper made.

The composition of K chemicals is the only secret thing about this process. Nothing unusual is involved. Process details are worked out with precision and there is every reason to expect that results can readily be duplicated.

7- H. L. Horn Process (17)

This process is understood to be that as revealed in United States patent 2,446,428 and as further described in The Sugar Journal, December 1949, pages 8-11. As described by Mr.Horn and his colleagues, E. E. Litkenhous and H. M. Phillips,on July 18, 1052 to the Department of Commerce, the procedure to be followed at the Paper Section includes these basic steps:

a- Operation of a rod mill to macerate the raw bagasse

b- Separation of the pith from fiber by means of a revolving screen.

c- Digestion of pith and fiber separately and separately chlorination and bleaching pith and fiber.

d- Blending of the separate pulps made from pith and fiber in preparation for making paper.

Processes 4,5,6, and 7 were run with 100% bagasse at the pilot plant of the National Bureau of Standards.

A standard process on wood was run for the purpose of control. The object of this test was to ascertain recoveries of the system at the Paper Section for comparisson with commercial operations. Serious variations might be attributed to system losses or excesive hydrolysis peculiar to the small rotary digester. A correction of all values of as much as 16 percent may be justified on this basis. However , no such correction was made.

The following table shows the operating conditions and materials used for this tests.

(b) Mechanical Method

1- Northern Regional Research Laboratory's process(19)

Treatment of the dry bagasse for about 30 minutes in cold water in the 3-foot Laboratory Hydrapulper freed the pith from the fiber without the production of the fine fibers due to cutting. The Hydrapulper used in the paper and board industry for

TABLE II

OPERATING CONDITIONS AND MATERIALS (17)

(Units pounds per 100 pounds (oven-dry) of whole bagasse)

	De LaRoza	Valite	Chemcel	Horn	Control Wood Process
Bagasse or wood chips, o.d., lbs.	100	100	100	100	100
Recovery after treatment, lbs.:					
Dusted	90	90	--	--	--
Prehydrolysis, conditions :					
Steam: T.(F.); hours at T	325;2.0	320;1.0 pH 2.0	--	--	--
Digester: Additions: Water, pounds	450	520	600	460	380
Sdium Hydroxide, lbs.	20.1	11.3	8.0	10.0	23.0
Other, including Na_2S: Na_2O eqvt.	5.1	0.7	3.3	10.8	5.8
Conditions-Steam: T.(F); hrs. at T	306;2.0	250; 6.0	243; 6.0	240;1.25	330;2.5
Causticity, percent	75	--	67	47.5	75
Sulfidity, percent	25	--	--	--	25
Recovery, pounds: Fiber	47.4	41.9	49.2	61.0	43.8
Na_2O, total equivalent	20.3	9.2	9.2	18.1	23.1
Wash, Na_2O loss, lbs.	0.40	0.18	0.19	0.37	0.47
Chlorination: Conditions					
Pulp consistency, percent	--	3.0; 3.5	3.0	4.0	3.25
Input, pounds:					
Fiber	--	41.9	49.2	61.0	43.8
Water	--	1,250	1,640	1,220	1,350
Chlorine (fred)	--	4.06	5.32	2.80	2.18
Alkaline extraction; conditions (open beater):					
Pulp consistency	--	4.0	4.0	3.25	3.25
Sodium Hydroxide equivalent lbs.	--	0.84	1.23	1.18	1.08
Hypochlorite bleach, condtions (open beater):					
Pulp consistency percent	4.0	4.0	4.0	3.5	3.25
Calcium hypochlorite, lbs.	4.2	3.6	3.9	3.5	0.58
NaOH, pounds	0.47	0.42	0.49	0.61	0.44
Yield of Fiber, lbs.	44.6	34.7	45.4	48.4	41.4
Freeness, Schopper-Riegler	710	690	495	725	850
Furnish (fiber as above), lbs.:					
Clay	5.10	1.85	0.10	7.26	2.00
Titanium dioxide	1.02	0.18	0.45	0.48	0.62
Rosin and alum	0.80	1.13	0.83	0.30	0.35

pulping waste papers or dried pulp, produces its pulping action by means of a rotor in the bottom of the tub which induces violent agitation. The pulp is not subjected to treatment between two metal surfaces, such as occurs in a hammer mill or rod mill.

The fiber suspension from the Hydrapulper is drained over a flat screen having round holes of 0.04 inches diameter. The material passing through the screen consists almost of dirt. The material remaining on the screen is separated into pith and fiber by a fractionation method . A rotary screen having 1/8 inch round holes is used in fractionation.

By the use of the above method commercially for separating pith and fiber, the dirt can be easily discarded. The pith contains a few very short fine fibers. The ratio of pith to fiber is 1 to 2.

(c) Mechano-chemical method;

1- Northern Regional Research Laboratory process (19)

For producing fine paper pulps from bagasse by the mechano-chemical process, the material was cooked with 15 percent chemical either kraft or caustic soda, for 3/4 to 1 1/4 hour at 210^{o}F. The fresh and stored bagasse samples from Florida and Louisiana were pulped easily under this conditions as shown in figure 1. Results on wheat straw pulp and on commercial wood pulps were included for comparison. However, the fresh Louisiana bagasse samples showed very high amounts of screenings due to the much greater proportion of large, thick, relatively dense, rind fiber bundles. The Florida bagasse, milled more heavily than the Louisiana bagasse, produces smaller rind fiber bundles. In commercial mechano-chemical pulping of bagasse, the incompletely penetrated and cooked rind fiber bundles would be separated from the well cooked pulp by a coarse screen and returned to a subsequent Hydrapulper charge for completion of cooking. A study of this ope-

ration is in progress.

Since the purpose of these preliminary studies was to evaluate the influence of pith and storage on papermaking characteristics and since the mechano-chemical process for producing fine paper pulps is not yet in commercial operation, the data presented in Fig. 1 were obtained from conventional pulping methods.

The majority of the cooks were made by the kraft process with twelve percent kraft chemical (33 percent sulfidity) for two hours at 338°F. (100 p.s.i.). Two cooks by the neutral sulfite process were included for comparative purpose, giving substantially the same results. The values for the various types of bagasse pulps shown in Fig.1 are averages, no distinction being made between the kraft and neutral sulfite processes.

The yields screened pulp from the whole bagasse either fresh or stored were slightly lower than that obtained from wheat straw by the mechano-chemical process. In contrast to wheat straw, which contains relatively

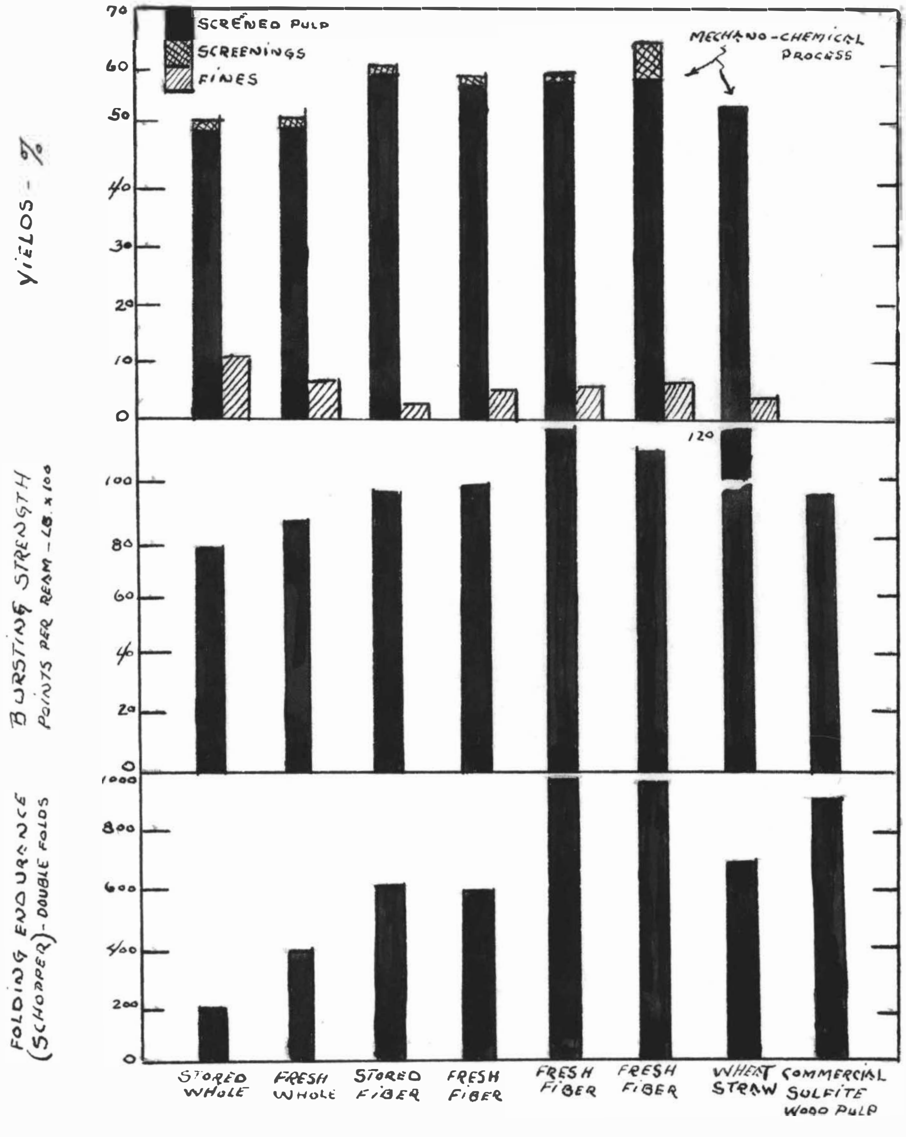

FIG 1. YIELDS OF SCREENED PULP, SCREENINGS, AND FINES, AND BURSTING STRENGTH AND FOLDING ENDURANCE OF BAGASSE PULPS FOR FINE PAPERS

non-fibrious nodes, heads, and so forth that are removed by screening and discarded, the screenings obtained from bagasse can be reduced to satisfactory fiber by further pulping. The yield of satisfactory pulp from bagasse, therefore, should be considered as the sum of the screened pulp plus the screenings as reported here. The bursting strength and folding endurance of the pulps from the whole bagasse were not as good as those obtained from either wheat straw or sulfite wood pulp, included in Fig.1 for comparison. This is to be expected since the pith in the whole bagasse tends to reduce the strength characteristics of the tru bagasse fibers.

In the case of the depithed bagasse fiber, the yields of screened pulp plus screenings were considerably above those obtained from the whole bagasse as well as above the yield of pulp from straw. The bursting strength of the pith free fiber pulp was better than that of the pulp from whole bagasse and this was also true for folding endurance. It must be rembered that some of the longer and better fibers are present in the outer rind of the cane; repulping of the screenings and including this additional fiber would probably raise still higher both the bursting strength and folding endurance of the resulting pulp. Particular attention is directed to the high bursting strength and folding endurance of the pulp from the depithed fiber from the fresh Florida bagasse. The strength properties of this pulp put in the same category as a softwood kraft pulp except, of course, for tear resistance,which is a property of pulp depending almost directly on the length of the fundamental fibers. This Florida pith-free fiber pulp is distinctly superior in strength to any of the hardwood pulps. It thus appears that a superior pulp for fine bleached papers could be produced from depithed, fresh bagasse. Based on these preliminary studies, there appears to be no valid explanation for the superiority of Florida fresh bagasse over Louisiana fresh bagasse samples.

Cost of Pulping Bagasse

It is technically and economically feasible to store bagasse for indefinite periods of time. The sugarcane grinding season is about 2 1/2 months in Louisiana and about 6 months in Florida and Puerto Rico. Year-round availability in these areas presents no difficulty; when properly baled, treated, and stacked,bagasse can be kept for several years without significant loss. In Hawaii the cane-grinding season extends throughout most of the year, thus requiring little or no storage for the bagasse produced.

Almost one ton of paper can be made from two tons of bagasse. While the United States is not a major sugarcane producer, ample quantities of bagasse are annually available in Louisiana and Florida to support at least two newsprint mills of economic size utilizing bagasse as a raw material. Even greater quantities of bagasse are avilable in Hawaii and PuertoRico, which together produce about three to four times as much sugarcane as the United States. Still greater supplies are available in Cuba, which alone produces two to three times as much as the United States and its Territories combined. On a world-wide basis about twenty-five million tons of bagasse are produced annually, with the United States and its Territories and Central America accounting for roughly one-half of the world total. Utilization of this tremendous potential supply depends upon economic conditions in each locality.(17)

According to Dr. Litekenhous of Vaderbuilt University Research, the following survey indicates the feasible utilization of bagasse in the paper industry. Costs figures indicate that bagasse can be obtained at a 100 tons-per-day pulping mill for $4.75 to $5.67 per ton of dry fiber and can be make into pulp ready for paper on board manufacturing for from $16.65 to $18.15 per ton of pulp as compared with Southern slush kraft pulp at $21.19, Pacific

Coast groundwood at $16.78 and cheap sulfite pulp at $36.00.(11)

In general a process using the following appears economically feasible:

A- Attrition (mechanically) shreadding of bagasse either wet or dry.

B- Hot water or air separation of soluble material and pith using screens, cyclons, centrifuging or decantation methods.

C- Subsequent semi-chemical, chemical and/ or physical treatment to handle the separate fractions according to their individual properties.

D- Using directly or blending with other pulp is standard paper making equipment.

Celotex and Godchaux process approach this suggested treatment, while Horn, Wittemore and Wells processes can all be made to conforme.

The cost per dry ton of processed bagasse fiber at the forming machine going into Celotex board (including the approximate 35% lost of pith, fermentation mechanical, etc.) was estimated between $10.00 and $11.00 this is mostly mechanical treatment with a slight soda cook. The Wells process upon which cost estimated were developed, indicates that with 45% loss in production the overall cost of producing pulps at the machines will vary bet - ween $16.00 and $18.00 per ton. If the pith and short fibered fraction is reduced to $10.00 / ton, the cost of the long and fine fibered material approximately will vary between $22.00 and $26.00 per ton compared to a ceiling price of approximately $70.00 per ton. These costs would be feasible in normal time when pressed by cheap wood pulp. The 45% loss presents the possibility of a good recovery in plastics and other by products.

Bagasse pulp can be used as an extender of kraft pulp in

quantities up to 40% of the weight of the Kraft pulp.

As a production comparison with wood pulps production the cost of dry bagasse per ton (excluding shrinkage and losses) is $4.75 to $5.00 per ton laid down at the mills with 45% losses the price reached $7.30 to $7.70 per ton useable pulp material. Wood varies from $6.80 to $21.54.

Added to this are the production costs which convert this material into useable pulp. This is estimated at $8.65 per ton dry bagasse pulp. The wood costs run from $7.86 to $ 29.85 per ton dry pulp. Wood is debarked, chipped, screned and beaten. Auxiliary equipment such as conveyors, pumps, piping, etc., makes up the wood pulping plant. In the use of bagasse the corresponding process requires rotary rod milling (or other attrition mills) screening, digesting, wasting and beating. In other words the wood chipper is replaced by bagasse attrition mills, the rest of the plant being modified for the separation of the fiber and pith fractions. The cost of the corresponding section of either (wood or bagasse) is comparable.

To obtain an estimate of the value of fresh depithed bagasse fiber to the southern paper and board industry, a comparison was made with southern pine as a raw material. Most mills in the South use the Kraft process. About eighty-five percent of the chemical used in cooking is recovered and reused in these mills. Either the caustic soda or Kraft chemicals in the spent cooking liquor from bagasse pulping could be recovered in the installed recovery system in a Kraft mill.

In making this comparison, it is assumed that, based in dry raw material , to produce easy-bleaching bagasse pulp will require twelve percent and to produce yellow pine pulp twenty percent active chemical, as $N_a2\ 0$; the yields of unbleached screened pulp will be 57 and 47 percent, respectively. In both cases it is assu-

med that 85 percent of the chemical is recovered. The chemical usage required for bleaching either of the pulps will be the same. The cost of yellow pine f.o.b. paper mill per 2,400-lb. cord is taken to be $16.00.

Unbleached Pulp

Southern Pine 47% Yield

Wood 1.91 cord at $16. (2.29 tons)	....	$30.56
Salt cake 315 lbs. at $22/ ton	....	3.46
Total	....	$34.02

Depithed Bagasse 57% Yield

Bagasse 1.74 tons	....	$32.44
Salt cake 143.5 lbs. at $22. ton	....	1.58
Total	....	$34.02

On this basis, 1.74 tons of bagasse would have a value f.o.b. paper mill of $32.44 or $18.65 per ton. At any delivered price below this figure, bagasse pulp would cost less than pine pulp. Assuming a $5. per ton freight rate from sugar mill to the paper mill, the bagasse would have a value of $13.65 per ton f.o.b. sugar mill.

This estimated value was presented by the Northern Regional Research Laboratory, (19) which concluded the cost of fresh, depithed bagasse would be very high if no profitable use could be found for the pith. Two such outlets suggest themeselves: use as fuel and use in feed as an absorbent for blackstrap molasses. With Bunker C fuel at $2.12/ bbl., pith has nominal fuel value at as sugar mill of $4.64/ ton; with gas at $.14/M cu.ft. a fuel value of $1.70/ ton.

The use of pith as an absorbent for blackstrap molasses offers more interesting and more profitable possibilities.

On the basis that pith has 60 percent of the nutritive value corn, it would be worth $29.80 per dry ton if corn is valued at a support price of $1.50/bu. With corn at $1.00/bu., pith would be worth $19.85/ ton as feed.

Approximate Estimate of Costs and Profits per ton of Producing Dried Baled Bagasse Fiber and Pellets of 50/50 Pith and Blackstrap Molases for feed.

(Value of Blackstrap not taken account)

Assumptions:

Bunker C fuel Oil	....	$ 2.12 bbl.
Natural Gas	....	.14 /Mcu.ft.
Corn support price	....	1.50 bu.
Bagasse fiber f.o.b. sugar mill	.	13.65 ton

	Pith		Fiber	
	Gas	Oil	Gas	Oil
Fuel value for Replacing Bagasse	$1.70	$4.64	$1.70	$4.64
Labor for Separating and Drying	1.50	1.50	1.50	1.50
Depreciation and Maintenance	1.50	1.50	1.50	1.50
Drying Fuel	.58	1.57	.58	1.57
Mixing with Molasses, Pelleting Bagging including labor	2.00	2.00	--	--
Bailing including Labor	--	--	2.00	2.00
Total Costs	$7.28	$11.21	$7.28	$11.21

Profits Per Ton from Pith and Bagasse Fiber

	Pith: Gas	Pith: Oil		Fiber: Gas	Fiber: Oil
As Feed	$29.80	$29.80	For Paper	$13.65	$13.65
Cost	7.28	11.21	Cost	7.28	11.21
Total	$22.52	$18.59		$ 6.37	$ 2.44

Increased Profit Per Ton Ground

On the basis that a ton of cane produces 300 pounds bagasse (dry basis) and that bagasse is composed of 30% pith and 70% fiber, the profit from the sale of pith for feed and bagasse fiber for fine paper production per ton of cane ground may be calculated. Since the profit to an operation where gas may be used as fuel to replace bagasse is greater than when oil is used, two sets of figures are presented.

Per Ton Cane Ground	Profit/Ton Cane — Fuel: Gas	Oil
90 pounds Pith	$1.013	$.837
210 pounds Bagasse Fiber	.67	.256
Total	$1.68	$1.09

Sufficient data are not yet available to make an accurate estimate of capital required for the installed process and equipment, or for operating costs, but an approximate estimate based on general experience with such operations is given above. These data indicate a possibility of additional income to a sugar mill of from $1.09 to $1.68 per ton of cane ground, depending on whether oil or gas replaces bagasse as fuel.

This is a most significant increase in total profits. Even with higher costs for product preparations, it is evident that a substantial profit could be secured by this method or by-product conversion.

Bagasse as a Papermaking Material

A- As a raw material for newsprint. (17)

As a result of an investigation undertaken by the Department of Commerce to explore the factors impeding the expansion of newsprint production in the United States and the investigation of the possibilities of utilizing new raw materials and technology in the manufacture of newsprint, bagasse was selected for initial studies in this pogram primarily because of the extensive history of research and developmental activity which had already gone into its use as a papermaking material.

The trial tests in this research were conducted by the National Bureau of Standards of the Department of Commerce. The resultant bagasse newsprint papers were subjected to every known test for comparison with standard newsprint. The tests of the National Bureau of Standards were supplemented by other work. The Goverment Printing Office made thorough printing tests and ran 100 copies of a sample issue of the Congressional Record on the new paper. A special panel of newsprint executives of leading newspapers gave personal judgem ents upon acceptability of the samples.

As stated by the Secretary of Commerce, "It has been clearly demonstrated that we can manufacture from whole bagasse a paper satisfactory in all important respects and superior in some to newsprint now currently in use. It is also indicated that the total costs of manufacturing newsprint from bagasse are at

least as low and in my opinion probably will eventually be much lower than production costs of newsprint now used. It is also clear that bagasse could be used economically as a blend with other pulp in the manufacture of standard newsprint and,because of its superior strength and other characteristics, may be suitable for the production of higher grade paper".

Papers were made in the paper mill at the Bureau, using four processes made known by their proprietors. These were:

De La Roza Corp., New York, N.Y.

Representative: Mr. Joaquin de la Roza, Sr.

Valite Corp., New Orleans, La.

Representative: Mr. W. J. Amoss.

H. L. Horn, New York, N. Y.

Representative: Mr. Harry L. Horn

Kinsley Cehmical Co. (Chemcel process), Cleveland, Ohio

Representative: Mr. Thomas Yetman

The bagasse fiber use was taken from a 1-ton lot furnished by the New Iberia Sugar Cooperative, New Iberia, La.

Paper was also made from the whole bagasse, as received, using a Kraft digestion process based on recomendations received from the Northern Regional Research Laboratory, Peoria, Ill. This process involved only methods and materials well known to the industry. The Northern Regional Research Laboratory does not endorse it as practicable process, however.

Another lot of paper was made by the same well-known kraft process using a lot of bagasse fiber depithed by the Northern Regional Research Laboratory. This process is identified in part by the initials N.R.R.L., but the same limitation as to that laboratory's endorsement is applicable.

In order to establish a criterion for comparison of the engineering data on these processes with a process using materials familiar to the pulp and paper industry, a lot of paper was made from loblolly pine chips supplied by P.H. Glatfelter & Co. A standard sulfate digestion was used for this process. Details were based on recomendations from the Forest Products Laboratory, Madison, Wisconsin. Quantities of all materials used and yields at the various stages of the processes were recorded.

Physicals tests and chemical analyses of the papers were made. For the purposes of comparison physical tests were also made on samples of newsprint obtained from the Washington Posts, The Washington Star, and the New York Times.

All tests and analyses were made by standard methods of the Technical Association of the Pulp and Paper Industry, where applicable.

Detailed data relating to the physical attributes of the papers made at the paper section of the Bureau of Standards are given in the table outlined , table three (3).

Many criteria determine the value of paper for use as newsprint are reducible to the following main categories:

1- Strength,2- Opacity,3- Printability,4- Pliability.

1- Strength

In all regards, papers made from bagasse are as strong as or stronger than standard newsprint. A part of this greater strength is desirable, especially in folding endurance and tear. As a group, bagasse produces a paper which is of such high quality that it may be said to be unnecessarily high for newsprint use. Of the proprietary products, all would be suitable for newsprint upon the basis of strength alone.

The paper made by H. L. Horn's procedure is unsuitable

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Table 3 (17)

	Standard Newsprint			Proprietary	Bagasse Newsprint			Control Newsprint		
	No.1	No.2	No.3					Bagasse		Loblolly pine
	New York Times	Washington Post	Washington Star (Spruce Mills)	De La Roza	Valite	Chemcel	H. L. Horn	Whole	Depithed N R R L	
Weight:										
25 by 40 in., 500 sheets lbs.---	38.5	38.9	37.6	41.4	38.4	41.5	49.5	37.2	34.0	31.5
24 by 36 in., 500 sheets lbs. ---	33.3	33.6	32.5	35.8	33.4	35.9	42.8	32.1	29.3	27.2
Thickness, in. ---------------------	.0037	.0034	.0035	.0032	.0029	.0033	.0041	.0031	.0031	.0031
Bursting strength, points ----------	7.0	7.0	7.0	11.0	8.0	10.0	13.5	13.0	10.5	12.0
Folding endurance, double folds:										
Machine direction --------------	4.0	4.0	5.0	13	7	9	12	45	9	44
Cross direction --------------	1.0	1.0	1.0	7	5	9	11	18	6	14
Tensile strength per 15 millimeters: (Schopper)										
Machine direction--------------	2.4	2.2	2.4	3.9	3.0	3.0	4.1	3.7	2.7	2.7
Cross direction --------------	1.3	1.2	1.2	2.1	1.8	2.0	3.0	2.6	2.3	1.5
Tearing strength (Elmedorff):										
Machine direction ------------	19	19	19	29	19	23	25	23	22	42
Cross direction --------------	22	23	23	43	18	22	24	25	22	66
Smoothness, sec. (Bekk) ----------	60	65	60	15	15	7	5.5	7	15	10
Ash, oven-dry basis -------------	0.25	0.25	0.24	13.2	5.4	18.4	14.9	8.0	6.5	4.2
Opacity, contrast ratio, dry, % ----	90	90	90	92	78	81	82	79	78	73
Fiber composition, percent :										
Chemical Wood ----------------	20	20	30	--	—	—	—	—	—	100
Bagasse ------------------	—	—	--	100	100	100	100	100	100	—

respecting thickness, being 0.0041 inches, with weight at 42.8 pounds per 500 sheets (24 by 36 inches). The commercial thickness is 0.0032 to 0.0037 inches and the commercial weight from 32 to 34 pounds. In this regard the Valite product is preferred while that of Chemcel is somewhat heavy. The paper made by the De La Roza process is slightly, althrough not significantly, heavy. This can readily be adjusted if desired because of the relatively high opacity.

2- Opacity

This factor is of great importance and is used as a significant criterion of the property of a newsprint to be printed on both sides without interfering with legibility. Commercial newsprints generally have an opacity of 90 while 88 is sometimes regarded as the permissible minimmum. A product with opacity significantly less than 88 may be considered unsuitable for newsprint and a product given a value in excess of 90 is unnecessarily good.

The De La Roza product is the only one which is acceptable with respect to opacity. Itis a premium product in this respect. Opacity could be reduced in one of three ways or by a combination: by decreasing thickness and thus weight, by decreasing the ash content; by decreasing the amount of the expensive titanium dioxide used in the furnish. The characteristics of the paper are such that a considerable latitude for modification is present making some cost reductions possible.

Opacity of the H. L. Horn paper is undesirable low. There is little to be done about it as the ash content is high as well as thickness. With a weight of 42.8 pounds, 30 percent greater than standard newsprint, there is little or no latitude for improving opacity.

The paper made by the chemical process is low in opacity. Paper thickness is close to ideal but the ash content is extremely high.

The Valite product is lowest in opacity. As ash and thickness are also low, improvement in opacity by changes in the furnish should present no great problems. It is believed that opacity of this paper can be markedly improved.

3- Printability

All newsprint samples made at the Bureau of Standards were submitted to the Government Printing Office for thorough printing tests, and a complete report obtained.

The sample of newsprint made by the De La Roza process was found suitable for newsprint purposes with standard news ink, but even better resources were obtained with ink wich is heavier than the standards new ink. Because of the low opacity of the other six samples they were unsuitable for printing newspapers. The De La Roza paper not only is nearly as good as standard newsprint respecting blackness, but is somewhat superior in the show-through factor. The Valite paper is comparable to newsprint in blackness, but the show-through is so great as to make this product of little if any value newsprint. The papers made by The Cemcel process and H. L. Horn are superior to the Valite product in show-through but inferior in blackness. In this tests the De La Roza paper alone fulfills requirements for satisfactory printability.

4- Pliability

One of the most difficult evaluations which had to be made relates to the complex of physical characteristics generally described as pliability of newsprint. Included in

the range of this concept are such attributes as softness, flexibility, rattle, tinniness, boardiness, ease of folding, compressibility, and resistance to deformation.

Since there is no adequate laboratory means of measuring this complex of physical qualities reliably, it was determined to obtain the subjective judgements of a representative group of experts qualified to appraise the quality of newsprint from the consumer's standpoint.

Accordingly , a panel of representative of a number of newspaper publishing organizations was convened. This jury was asked to rate wach sample of newsprint as "acceptable", " marginal", " unaceeptable", or " inconclusive " . Samples were identified only by code.

In order to provide a basis for judging the validity of the results, the newspaper representatives were asked to rate each sample as too opacity and printability, as well as pliability. The actual opacity of each sample had been determined on the basis of careful physical tests. The departure of the actual ratings from the known opacity of each paper thus provided a guide as to the basis of the subjective measurement. It was found that a fairly high degree of reliability obtained when " marginal " ratings were included with " acceptable " ratings. Accordingly, this method of scoring was used in computing ratings for pliability. It was the general opinion of the representatives that printability was not susceptible of reliable subjectives judgements. Since this was confirmed by erratic results of obtained, printability ratings were not use in scoring.

The results as to pliability, using marginal and acceptable ratings as a percentage of total ratings in each case,

are as follow :

Standard newsprints	....	96
Bagasse and pine paper::		
Depithed bagasse	....	85
Chemcel	....	80
Whole bagasse	....	70
Loblolly pine	....	70
De La Roza	....	65
Valite	....	50
H. L. Horn	....	30

In the newspaper jury's rating of newsprint as to pliability, the Chemcel paper was considered acceptable or approximately so by 4 out of 5 votes cast: the De La Roza paper by 2 of every 3 votes cast, the Valite by 50 percent of the votes cast and the Horn paper by 30 percent of the votes cast.

No unusual reliability is claimed for the approach used in this case. It was intended to provide some means of unbiased indications asto the judgements of newsprint consumers in appraising a characteristic of newsprint which so far defies objective measurement.

Analyses and observations were made at the National Bureau of Standards for chemical composition and microscopy of all pulps. The object was to contribute to the general technical knowledge so far as a limited number of tests would permit, and to establish such technical information as would in some part contribute to the improvement of bagasse pulps.

Several statements relating to the nature of bagasse pulps are commonly repeated. Among such assertions are these:

1. Pentosans should be extracted from the raw pulp.
2. The prescence of pith is undesirable in a pulp if a pliable paper suitable for newsprint is to result.

The limited data of these tests do not sustain these opinions. The pulp made by the Valite process showed least pentosans, recovery of pulp was least, and the paper which resulted was not among the best. All other products,except that of the De La Roza process, showed an increase in pentosan content and none of these products was exceptional for use as newsprint. The De La Roza product reduced the pentosan content by half and the resulting paper was, generally, exceptional for use as newsprint. While pentosan content may be a factor in determining the quality of paper, the evidence of the tests made at the Paper Section do not appear to demonstrate the mechanisim or correlation.

Presence of pith in the pulp is generally regarded as undesirable if the product is to be newsprint. The data shown in Table 4 do not support such a conclusion. The greatest ratios of fiber (mechanical tissue) to pith in the pulps are exhibited by lobloly pine and depithed bagasse.

These ratios are 4.0 and 3.8, respectively. The papers which resulted were not exceptional for use as newsprint. Pulps from whole bagasse (standard kraft cook) and the De La Roza process gave ratios of 2.5 and 2.2 for fiber pith. The paper made from the former is decidely inferior for use as newsprint, while the later is best. Finally, the pulps made by the Valite,Chemcel, and H. L. Horn processes exhibit the lowest fiber to ratios, 1.3 to 1.6. The papers made from these pulps are in no wise exceptional.

It would appear that neither pentosans nor pith alone, nor in combination, are sufficient to define the characteristics ofpapers made at the Paper Section.

Table 4

Incidence of Fiber and Pith in Bleached Pulps

	Fiber Pith 1	Whole Pith fragments 2	Fiber incidence relative 3
Propietary bagasse newsprint:			
De La Roza	2.2	0.8	55
Valite	1.3	1.0	33
Chemcel	1.6	.8	40
H. L. Horn	1.5	.8	37
Control newsprints:			
Whole bagasse	2.5	5.9	63
Depithed bagasse, NRRL	3.8	.5	95
Loblolly pine	4.0	1.0	100

1- Microscopic count; number of mechanical fibers per pith cell.

2- Microscopic count; number of whole pith cells per fragments equivalent to one pith cell; fragmentation is in great part a funcion of the character of cook.

3- Relation of fiber-pith ratios where loblolly pine (4.0) equals 100.

Estimated cost of producing one ton of newsprint from bagasse is $37.65; standard newsprint is $41.20. Factors incided are raw material, electric power, steam and chemicals. It was produced almost one ton of newsprint from two tons of bagasse.

In an experimental run, done at the Forest Products Laboratory, Madison , Wisconsin, newsprint was made out of bagasse.(13) The Pulp was prepared from bagasse by a prehydrolic treatment consisting of a short water cook, which was followed by a conventional sulfate pulping treatment. The prehydrolic treatment gives some control over the removal of hemi-cellulose and the softness and strength characteristics of the pulp. The pulp was bleached in a single stage with hypoclorite, clay and celite filler were added to improve the opacity of the sheet.

The pulp was not beaten or refined for the paper trials, A news-weight sheet of the paper had physical properties approaching closely those of standard newsprint. Though a considerable amount of clay was used, the opacity was lower than that of standard newsprint. On the other hand, the paper was stronger and whitter than the standard. The operating characteristics of the stock indicated it could be run on a fast commercial machine.

These tests were done for the De La Roza Corporation who was planing to build a $15,000,000 plant at Clewston, Florida to produce 45,000 tons of newsprint annually and the cost would not be more than newsprint from wood. (6)

The following, table 5, are the test results at the Forest Products Laboratory trials and a sample of the bagasse paper.

Ream weight [1]	.... lb.	36.1
Thickness	.... mils	2.9
Density	.... gm.per cc.	.69
Bursting strength [1]	.... pts. per lb.	.31
Tearing strength [1]	.... gm.per lb.	1.07
Tensile strength	..... lb.per inch width	8.40
Oil penetration	................seconds	43.9
Porosity	.... seconds	37
Opacity	.... percent	86.1
Brightness	.... percent	71
Ash	.... percent	11.0

[1] Ream of 500 sheets, 25 X 40 inches

Machine run No. 3589

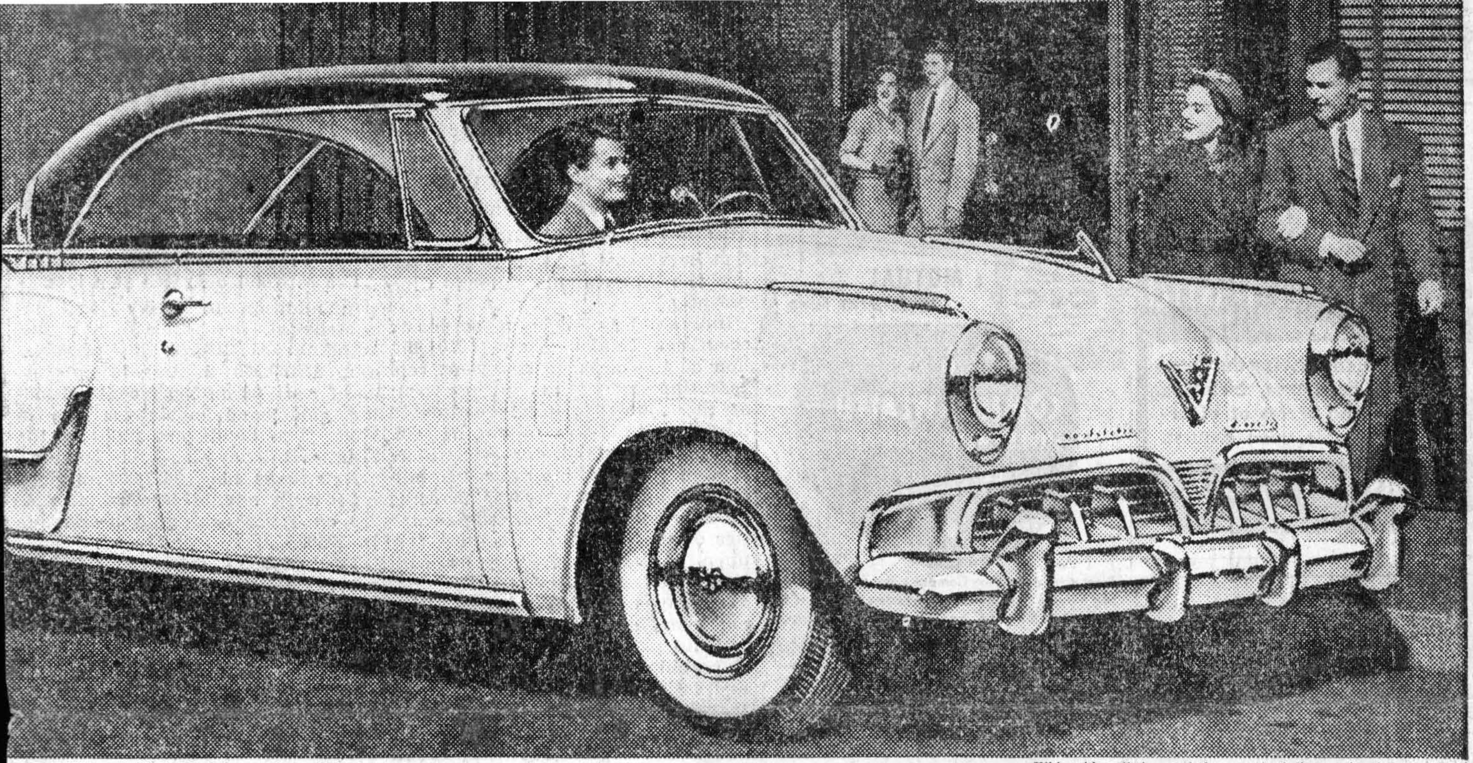
100% Bagasse prehydrolysis
bleached sulfate pulp.

Made from 100% BAGASSE including

the pith

by the de la Roza Process

Following is a sample of newsprint type paper made by the De La Roza process from whole bagasse and printed at high speed on the presses of the Journal of Commerce. (18) This was made on a pilot scale before the tests at the Bureau of Standard and is not of as high a quality as the paper made there. The other sample is from a hand sheet made from the same pulp, and shows the adaptability of this furnish to the production of higher quality papers.



White sidewall tires and chrome wheel discs optional at extra cost

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Studebaker is one of America's lowest price cars

er Studebaker Automatic Drive or Overdrive—and glare-reducing tinted glass—at extra cost.

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is referred to in the insurance business as "acquisition cost," and in the insurance business (including old line companies) this acquisition cost runs from 75 per cent to 125 per cent of the first year's premiums. In our case it is limited to 50 per cent."

The company sells plans with an insurance feature also. However,

Highlights

Corporate securities accounted for more than one-third of the total liquid assets held by Americans at the end of 1951, Grady Clark, vice president and general sales manager of Investors Diversified Services, Inc., said in addressing the Minneapolis Lions Club recently.

Individual holdings of corporate securities totaled about $210 billion at the close of last year, representing more than 38 per cent of the country's total estimated liquid assets of $550 billion, he said.

"This means that for every man, woman and child of our 155 million population there was invested an average of $1,355 in the securities of the industries we must rely upon to keep supplying us with the goods, the services, the jobs and wages and taxes that keep our economy functioning.

"This is the kind of 'public ownership' that can and must be aggressively encouraged, as an integral part of our capital enterprise system."

Mr. Clark predicted that assets of the country's mutual funds will approach or exceed the $4 billion mark at the end of 1952, if sales continue at present levels.

* * * *

Distributors Group, Inc., has recently issued two studies on tobacco stocks, pointing out that the proportions of tobacco stocks held for both the Fully Administered Fund and the Common Stock Fund of Group Securities, Inc., have recently been substantially increased. It also features Tobacco Shares.

Group also has issued a folder on the electrical and electronic industry, featuring Electrical Equipment Shares.

* * * *

National Securities Series has filed a registration statement with the SEC covering shares aggregating $63,860,000. The offering will be made through National Securities & Research Corp., sponsors, underwriters and managers of National Securities Series.

* * * *

Colonial Associates, Inc., distributors for Gas Industries Fund, Inc., has issued a summary of activities in the Williston Basin, pointing out that a number of companies represented in the fund's portfolio are participating in oil and natural gas exploration and drilling in the area.

Willys Gets $900,000 Electronics Order

Special to Journal of Commerce

TOLEDO, June 16.—Willys-Overland Motors, Inc., announces receipt of a subcontract valued in excess of $900,000 for manufacture and assembly of military electronic equipment, production of which will take place at the company's aircraft division, Anderson, Ind.

C. P. Weedman, manager of both Willys aircraft engine and electronics divisions, said the subcontract was received from the General Electric Corp.'s Electronics Park at Syracuse, N. Y.

Manila Railroad Plans Discussion on Debt

MANILA, June 16 (AP).—British bondholders of the Government-operated Manila Railroad have been invited by the line's directors to send a representative to discuss the line's indebtedness.

The railroad operates at a loss.

In addition to heavy local indebtedness, the railroad has outstanding $13,218,500 in principal and $7,169,500 in unpaid interest as of April 30 on 5 per cent refunding gold bond mortgages due in 1956. The bonds are held by the Manila Railway Co., Ltd., London.

Americans hold $607,000 in principal with unpaid interest of $24,280 on 4 per cent gold bonds due in 1959.

The railroad owns considerable real estate it could sell to meet operating deficits but officials say these assets could not be disposed of without consent of the bondholders.

P. M. A. Honors L. A. Appley

The New York Personnel Management Association's Award of Merit for outstanding achievement in the field of personnel relations was presented to Lawrence A. Appley, president of the American Management Association, at an Association dinner at th eBrass Rail Restaurant last night. Charles A. Anderson, chairman of the Association, presented the bronze plaque to Mr. Appley.

Mutual Fund Sha

	Bid	Asked
Aberdeen Fund	.93	1.02
Affiliated Fund	4.88	5.28
Am Bus Shares	4.00	4.33
Am Mutual Fund	11.88	12.92
Axe-Houghton Fd Inc	9.80	10.72
do B	18.40	20.0[illegible]
Blue Ridge MF, DRS	9.15	10.00
Bond Inv T Am	21.50	23.12
Boston Fund Inc	23.10	25.01
Bowling Green Fund	*9.02	*9.03
Broad St Inv Corp	22.44	24.26
Bullock Fund	24.09	26.33
Canadian Fund Inc	11.82	12.80
*Century Shares Tr	14.30	15.40
Chem Funds	21.39	23.13
Commonwealth In Co	6.90	7.50
Composite B & S	15.07	17.04
Composite Fund	12.80	13.92
Consolidated Inv	27	30
Delaware Fund	16.50	18.21
DIVERSIFIED FUNDS, INC.—		
Agriculture	11.90	13.11
Automotive	8.80	9.64
Aviation	10.25	11.23
Bank Stock	14.17	15.53
Building Supply	10.91	11.96
Chemical	17.72	19.42
Corporate Bond	10.03	11.28
Div Com S R F	5.2	5.71
Diversified Inv Fd	13.30	14.58
Diversified Pfd St	11.60	12.71
Elec Equip	13.06	15.00
Insurance Stock	14.07	16.08
Machinery	12.18	13.29
Merch Series	12.83	14.06
Metal	12.78	14.01
Oils	31.62	34.65
Pac Coast In Fd	13.03	14.94
Public Utility	10.08	11.05
Railroad	8.29	9.09
Railroad Equip	8.63	9.46
Steel	9.35	10.25
Tobacco	9.01	10.86
Diversified T Sh E	9.01	10.25
Dividend Shares	1.91	2.09
Dreyfus Fund	10.23	11.12
Eaton & How Ba F	31.78	33.98
Eaton & How St F	23.03	24.84
*Equity Fund	5.16	5.35
Fidelity Fund Inc	17.65	19.08
Financial Ind Fund	2.59	2.84
First Mutual Tr	5.70	6.31
Founders Mutual Fd	8.04	8.74
Franklin Cus Fd pf	7.12	7.80
do Com Series	6.79	7.45
Futures Inc	3.23	3.51
Fundamental Inv	19.88	21.79
Gas Indus pfd	20.72	22.40

Gen Capital Cor		
Gen Investors		
GROUP SECURIT		
Automobiles		
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Building		
Chemical		
Com Stock Fu		
Elec Equip		
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General Bond		
Indus Mach		
Institutional B		
Investing Co		
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Merch Shares		
Mining Shares		
Petrol Shares		
Railroad Bond		
R R Equip		
RR Stock Sha		
Steel Shares		
Tobacco		
Utilities Share		
Growth Co		
Guardian Mutual		
Howe Plan Fd In		
Hudson Fund		
†Income Foundati		
Incorporated Inv		
Independence Tr		
INSTITUTIONAL		
Aviation Group		
Bank Group Sh		
Insurance Group		
Stock Bond Gro		
Inv Co of Amer		
Inv Tr Boston		
Inv Management		
KEYSTONE CUST		
do B-1		
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do K-1		
do K-2		
do S-1		
do S-2		
do S-3		
do S-4		
Knickerbocker Fd		
Lexington Tr Fd		
Loomis Sayles		
MANAGED FUND		
Automotive		
Business Equ		
Elec Equip		
Gen Ind		

B- Corrugating and Liner Boards (19)

Whole stored sugarcane bagasse may be pulped to produce satisfactiory 9-point corrugating board with yields of more than 70 percent, as shown by the Northern Regional Laboratory in 1945. Lime and caustic were used as pulping agents in a rotary digester. The results were confirmed in a commercial trial in a Midwest strawboard mill.

Since then studies by this Laboratory have shown that Lime-cooked pulps tend to give lower crush resistance values than are obtained by cooking with caustic soda. The strawboard industry now has generally ceased to use lime as cooking chemical.

In additions the N.R.R.L. has developed a new, revolutionary method of pulping known as the mechano-chemical process which has received succesfull commercial trial in one of the strawboard mills. Briefly, this process consists of pulping at boiling temperatures in an open vessel of the Hydrapulper type. The rotor in the Hydrapulper causes violent agitation of the water and pulp, producing a powerful vortex. The rapidly moving material in the tub is repeatedly struck by the vanes on the rotor and those on the sides of the tub. This causes rapid diffusion of chemicals into and out of the fibers with consequent rapid pulping action.

The conditions for cooking bagasse for corrugating pulp in the Hydrapulper were 8 percent sodium hydroxide, basis bone-dry bagasse, at 9 percent consistency for 3/4 to 1 1/4 hour at 210°F. The variations in cooking time depended on the rate of pulping. The pulps were washed, defibered, and tested for strength by standard TPPI methods.

The averaged data on the yields of washed pulp and fines and on the bursting strength and crish resistance of the bagasse

pulps for corrugating papers or boards are illustrated in Fig.2. Results on wheat straw pulp and on commercial wood pulps for cO-rrugating are included for comparison. It may be concluded from these data that satisfactory corrugating pulp may be prepared from either stored or fresh whole bagasse. The yields of washed pulp from bagasse are in same range as those obtained from wheat straw, with the stored whole bagasse giving a somewhat higher yield. A somewhat lower yield is obtained from the fresh whole bagasse because it still contains sugars and other fermentable materials soluble in water. From the standpoint of bursting strength and crush resistance, the bagasse pulps are equal to straw pulp. The bagasse pulps have somewhat lower bursting strength but higher crush resistance that the average of three commercial wood pulps included in this test.

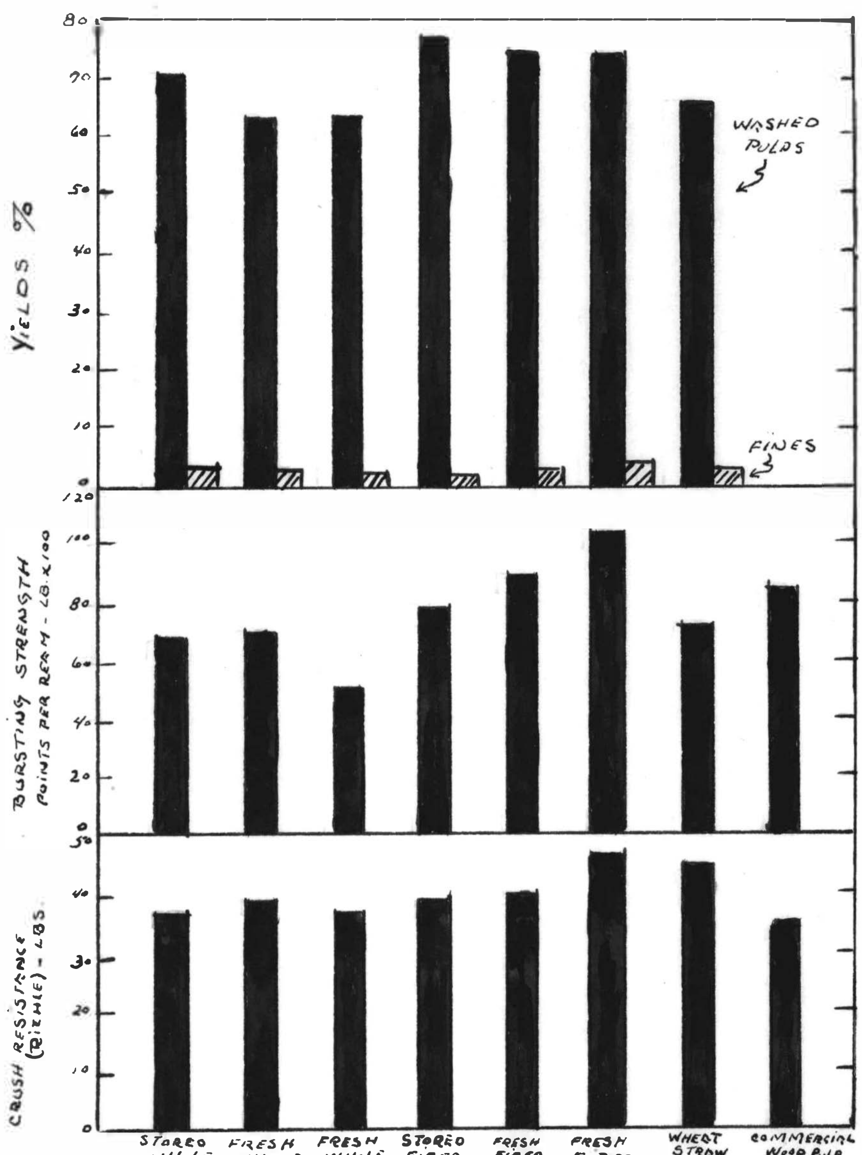


FIG. 2 YIELDS OF WASHED PULP AND FINES, AND BURSTING STRENGTH AND CRUSH RESISTANCE OF BAGASSE CORRUGATING PULPS.

As expected, larger yields of pulp were o obtained, from the pith-free fiber. The yields of washed pulp were even higher than those obtained from straw. The depithed fiber pulps were superior to those obtained from the whole

bagasse. The pith-free fiber pulp from the fresh Florida bagasse was considerably better than that from the stored or fresh,Louisiana material in both bursting strength and crush resistance. The Florida pith-free bagasse pulp was superior to straw and cOmmercial wood pulps. In fact, it had sufficiently good bursting strength and other characteristics to make it decidely suitable for blending with southern pine kraft pulp to make liner board of high quality.

Building board, insulating, acoustic material, etc. which is marketed in practically every country in the world are now produce in large quantities by the Celotex Corp,, in Louisiana. This company was the first to produce successfully and commercially products manufacture from bagasse, and it has steadily expanded until its operations are now very extensive.

Miguel A. Cabrera
February, 1954.

Outline of Planned Experimental Procedure

The projected experiments will be performed under the conditions described for a mechano-chemical process developed at the Northern Regional Research Laboratories for pulping bagasse.

With the available equiptment installed in the Paper Technology laboratory of Western Michigan College, the mechano-chemical process will be followed as closely as possible in order to obtain the most desirable results.

Pulping

In the pulping operation 200 grams (moisture free) of raw bagasse will be slowly and gradually added to four (4) liters of hot water and thirty (30) grams of caustic soda contained in a stainless steel pail. During the pulping process a temperature of 210 °F will be mantained by periodical steam injections.

This stock at atmospheric pressure will be agitated for the period of one hour in a drill press with a disintegrator having a vertical shaft with a 3.5 inch diameter slotted disk at its lower end and driven at a speed of 3,666 r.p.m. This agitation is expected to produce the effect of the Hydrapulper action.

Six different batches will be treated under identical conditions in order to obtain enough pulp required for further treatment.

Washing

The washing of the mildly cooked bagasse will be done by dilution and decantation in order to avoid premature fractionation by loss of " fines ". This will be done in a crock; sodium bicarbonate will be used to eliminate residual causticity, if any.

Beating

The washed stock will be beaten for 15 minutes according to TAPPI Method T 200 m-45 at a starting temperature of 20°C and a consistency of 1.57% . The purpose of this beating is to give additional mechanical treatment to the fibers and to liberate the individual cell elements.

Fractionation

The Bauer-McNett fiber classifier will be used for the fractionation of the bagasse fibers. This consists of a series of elliptical tanks each of which is equipped with a removable screen of progressively diminishing mesh. In each tank there is an agitator and a mid-feather parallel to the screen, which helps to maintain a high, uniform velocity of the stock across the surface of the screen.

The fractionation will be done through 10 mesh, 20 mesh, 35 mesh and 150 mesh screen plates.

The process as used at the Northern Regional Research Laboratories calls for round holes in the fractionation; while square holes screens will be used for this work for the purpose of obtaining the desired results with the available equipment.

Ten (10) grams (moisture free) samples will be run in a constant level of about three (3) gallons of water per minute during 20 minutes.

An estimated calculation gives an average recovery of fractions of about 1.25 grams (o.d.) per screen from every ten gram sample. In order to be able to make 10 handsheets of about 1.2 grams (o.d.) from every screened fractions,a minimum of ten different fractionations will be run.

The preservation of fibers will be done with sodium pentachlorphenate in amounts of one (1) gram per 1,000 grams of stock.

Identification of fractions

For the purpose of the identification of the fractions obtained in the fractionation, determinations of the ratio of pith to fibers will be performed under the microscope. The TAPPI Method for fiber analysis, T 401 m-53, will be used for this process.

Handsheets

Handsheets of about 1.2 grams (o.d.) will be formed and tested for strength tests; i.e. tearing resistence tensile strength , bursting strength and thickness. Apparent density will be established by calculation, as described in the TAPPI Method T 220-m-46. The folding endurance will be done in the M. I. T. apparatus according to TAPPI Method T 423 m-50.

Handsheets will be formed from fractions obtained in the fractionation. If bagasse fibers have been separated from pith cells, handsheets of 100% fibers will be done and also fiber and pith cells will be blended for comparison purposes.

EXPERIMENTAL WORK

The experimental work was carried out as outlined by the planned experimental procedure.

Bagasse samples from Louisiana and Puerto Rico were used. The conditions of the raw bagasse from Louisiana, obtained by the courtesy of Celotex Corporation, showed that it had been stored some - time and a considerable amount of dirt and sand were present. This Louisiana bagasse will be identified as sample A in the report.

The raw bagasse from Puerto Rico was a fresh, clean sample; it will be further identified as sample B.

PULPING

Six different batches of sample A were cooked under the following conditions; 200 grams of air dry raw bagasse were added to four liters of hot water and 30 grams of caustic soda, contained in a stainless steel pail. The mixture was agitated in a drill press with a slotted disk mounted at the bottom of a shaft driven at a speed of 2,133 r.p.m. The temperature was mantained at a reange of 80° to 86° C by supporting the pail on a hot plate, using cardboard to cover the pail and injecting steam periodically to compensate losses by evaporation. The time of cook for every batch was one hour.

Sample B was cooked in a similar manner, although continuous steam injection kept the temperature at a range of 94° to 98° C with a speed of agitation of 3,666 r.p.m. Only one batch was cooked (200 grams air dry and 30 grams caustic soda) and conditions of cook caused better fiber separation and softening than sample A.

WASHING

This was done by dilution and decantation. The decanted liquid was screened through a 150 mesh sieve to catch fines and pith cells in suspension. After washing was completed, sample A stock had a pH of 7.4. This stock contained a considerable amount of sand. The yield obtained from sample A cooks was calculated as 52%, air dry basis.

In sample B washing operation, the decanted liquid contained very light fines in suspension. They were recovered on a 150 mesh sieved separated and kept in a jar. This sample which microscipical count revealed to be 5.5% fibers, 85% pith cells and 9.5% vessels by numbers, was estimated to weigh about 14 grams (o.d).

The yield from sample B cook was calculated as 85%, with no sand present in the stock.

BEATING

Sample A stock was diluted to a consistency of 1.68 submitted to the following beater run.

The Valley beater was run for eight minutes, by hanging different weight on the lever every two (2) minutes period. For the first two minutes 5.73 pounds weights were used, 7.94 lbs. for the second, 13 13.45 pounds for the third and 15.61 pounds for the fourth two minutes period of beating. At this point a Canadian Standard freeness of 455 milliliters was obtained.

Sample B stock was beaten at a consistency of 1.05% in order to improve the circulation of the stock in the Valley beater. This stock being better cooked than sample A, required only six minutes, under the same weights for the three, two minutes, periods to give a Canadian Standard freeness of 433 milliliters.

FRACTIONATION

Following the beater run, part of sample A stock was fractionated in a Bauer-McNett fiber classifier, using 10, 20, 35 and 150 mesh screens. Ten (10) grams (o. d.) samples were run for twenty minutes in eighteen different fractionations.

The fraction retained by this fractionation in the 10 mesh screen was discarded because all of it was estremily coarse material.

For the purpose of washing and cleaning the individual fractions, a refractionation process was carried out. The fibers retained in the 10 mesh were used for handsheets. Sand still was found present in the 150 mesh fraction.

After forming handsheets for strength tests from the fraction retained by the 150 mesh screen (-35 + 150) the remaining fraction was fractionated and refractionated using 48,65, 100 and 150 mesh screens.

The following table V shows a quatitative recovery from the fractionation of sample A.

The fractionation resulted in a good separation of fibers according to fibers length as was further seen in a microscopical analysis. Losses were observed as sand as well as fines.

TABLE V

DISTRIBUTION OF FRACTIONS

Screen Mesh	Basis Original %	Recovery %
+ 10	3	5
*-10 + 20	14	20
-20+ 35	14	20
-35+ 48	6	10
-48 + 65	9	15
-65 + 100	14	20
-100 + 150	6	10
Total	66	100
Losses	34	--
Total	100	--

* - means passes through , + means retained by.

IDENTIFICATION OF FRACTIONS

In a microscopical analysis the constituens of the bagasse were identified as fibers, pith cells and vessels. Each individual fraction was analyzed and quantitative percentages by number determined. The following table is a relation of the microscopical analysis of the fractions from which handsheets for strength tests were made.

The sample A analysis was done on the unfractionated stock, Sample B was analyzed after partially depithed in the washing process, this is noticed by the lower percentage of pith cells present as compared to sample A.

The analysis of the fractions from the fractionation shows that the separation of fiber from pith cells becomes more and more difficult as the mesh of the screen increases, or as the fiber length diminishes, and that the bagasse after pulped will notbe succesfully separated in fibers and pith cells. by fractionation.

TABLE VI

MICROSCOPICAL ANALYSIS

Mesh	Fibers	Vessel	Pith
	%	%	%
+ 10	100	0	0
- 10 + 20	88	2.5	9.5
- 20 + 35	82	7	11
- 35 + 48	79	5	16
- 48 + 65	63	1	36
- 65 + 100	55	8	37
- 100 + 150	48	11	41
- 35 + 150	71	10	19
Sample A	60	8	32
Sample B	70	5	25

HANDSHEETS

From every fraction obtained by the fractionation process, a number of handsheets were made in a British Sheet machine for strength tests.

Handsheets from sample B were made after the stock was run through a 10 cut diaphragm screen to remove coarse material. For sample A handsheets the stock after going through the 10 cut diaphragm screen was freed from sand and heavy material present by decanting for a moment and pouring slowly in other pail to leave undesired material at the

bottom of the pail. This was repeated several times until the stock was free from sand.

The handsheets were tested for bursting strength, tensile strength, tearing resistance, folding endurance, basis weight in grams per square meter, apparent density and thickness.

The following table VII and figure 3 are the calculated results of the strength tests as outlined by Tappi Standards.

TABLE VII

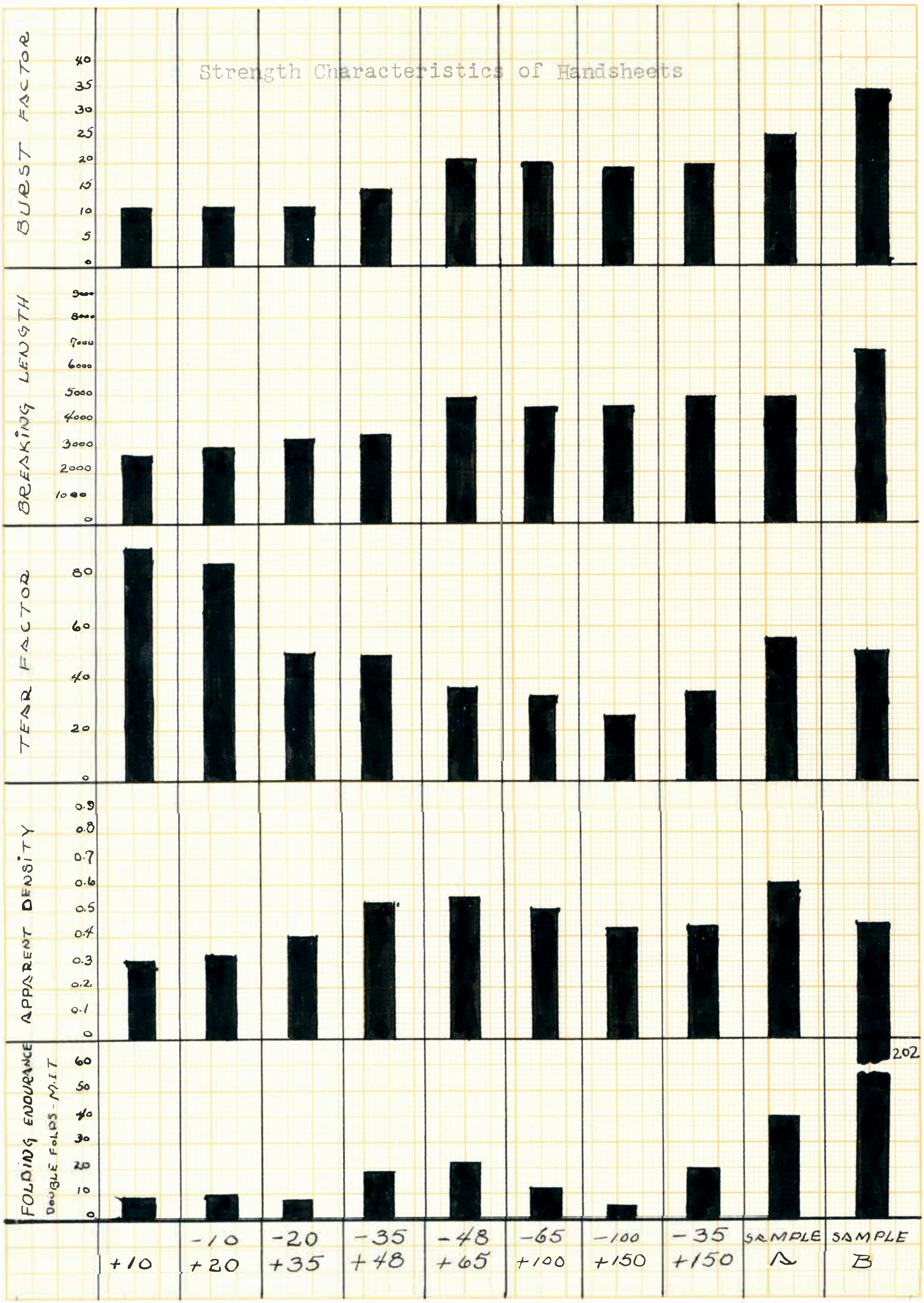
Fractions Mesh	Basis Weight	Burst Factor	Tear Factor	Breaking Length	Density (apparent)	Fold M.I.T.	Fold Range
± 10	71	12.6	91	2,640	0.314	8.5	2-14
-10±20	61.5	13.05	83.8	3,000	0.327	9.4	7-15
-20±35	69	12.97	51	3,333	0.403	7.14	4-10
-35±48	98	15.2	49	3,430	0.537	17.7	15-19
-48±65	96	21	37.5	4,820	0.555	21.5	12-28
-65±100	94.6	20	33.8	4,480	0.505	11.7	5-19
-100±150	73	17.9	26.3	4,560	0.43	4.5	4-5
-35±150	71.50	19	35	4,950	0.44	20	11-28
Sample A	126.2	25.5	50.8	4,900	0.613	39.6	20-61
Sample B	65	34.5	50.8	6,700	0.465	202	115-367

Evaluation of Results

Fractions retained by 10 mesh and 20 mesh screens were long fibered with practically no fibrillation and none to few pith cells present with a high tear factor as only significant strength characteristics.

The fraction retained by 35 mesh screen was very similar to the 20 mesh fraction in strength characteristics but showed a marked difference in the tear factor. This differece in fiber length did not seemed to affect the other strength factors while its pith content is the same.

Figure 3


Strength Characteristics of Handsheets
BURST FACTOR
BREAKING LENGTH
TEAR FACTOR
APPARENT DENSITY
FOLDING ENDURANCE
DOUBLE FOLDS - M.I.T
202
+10
-10 +20
-20 +35
-35 +48
-48 +65
-65 +100
-100 +150
-35 +150
SAMPLE A
SAMPLE B

The fraction retained by the 48 mesh screen has a slightly higher pith content and similar tear factor and breaking length as compared to the 35 mesh fraction, but shows a considerable gain in density with improvement in burst factor and folding endurance.

The 65 mesh fraction contains shorter fibers and over twice the pith content of 48 mesh fraction with very similar tear factor. Other strength factors are very significantly higher than other fractions with a lower or higher mesh screen. The pith content of the 100 mesh and 150 mesh fractions are similar to that of the 65 mesh fraction, but with lower strength characteristics. The handsheets from 65, 100 and 150 mesh screen showed and increasingly high stiffness and rattle.

The fraction - 35 + 150 mesh, containing the 48, 65, 100 and 150 mesh screen together, unfractionated, has very similar strength characteristics as the 65 mesh fraction alone, with half its pith content. While it was noted to contain some sand its handsheets were higly rattle and stiff.

Sample A, as compared to its fractions, shows as a rule, higher strength characteristics. Whereas compared to Sample B, The sample A shows only ~~shows~~ higher density. It is suspected that the better conditions of cook and cleaness of sample B might have accounted for its higher strength characteristics, while its pith content is lower.

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