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BAGASSE FOR PULP AND PAPERMAKING

A Technological Information Package

Prepared for the
Industrial and Technological
Information Section

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* The following report gives the names of some of the firms that are known to manufacture and/or trade in this commodity, but the list should not be regarded as exhaustive. Inclusion in this list does not imply any endorsement by UNIDO. The views and opinions expressed in this paper are those of the consultant and do not necessarily reflect the views of the secretariat of UNIDO. This document has not been edited.

PREFACE

As a result of the considerable progress that has been made lately in the utilization of bagasse as a raw material for pulp and papermaking, a new and updated information package is offered by UNIDO in this field.

Most of the worldwide technical literature published in the period 1980-1988 from a variety of information sources has been collected. evaluated, selected. organized and compiled in this package.

As no annotated bibliography was found that covered this period, a retrospective information search was carried out. Over 120 abstracts (part II) and references (from more than 500) were considered relevant to researchers and technicians involved in pulp and papermaking from bagasse.

A detailed list of sources including books, technical articles, papers, reports and catalogues supporting the present work is given in the bibliography.

CONTENTS

INTRODUCTION

According to existing literature, experts agree that there is a promising future for non-wood plant fibres in pulp and papermaking. It is expected that by 1990 worldwide non-wood plant pulp production will have risen from 7% of total pulp production to 10%.

Of the many non-wood agricultural fibres used for pulp and papermaking, bagasse is the most important. As for the last 25 years, there is no doubt that it will continue to be in the forefront in the near future. In addition, its production is increasing faster than that of other non-wood plant fibres and may represent for this decade as much as 2% or more of total world production by 1990, compared to less than 1%, at present. Already, several large bleached bagasse pulp and paper mills of 250-300 MT/day capacity are in operation: others are under construction. Similarly, many expansion programmes are also underway at existing bagasse pulp and papermaking mills all over the world.

Bagasse has all the requisites to replace traditional raw materials for the economic manufacture of paper. It is a fast renewable natural fibre resource and has the distinct advantage over other agricultural residues that it involves no problem of collection. It is thus, not necessary to spend considerable amounts on its procurement, transportation, etc. This and other advantages are cited by M.Rao [2.7].

The relation between the amount of cane sugar produced and the resulting bagasse varies widely from area to area and even from mill to mill. As a rough estimate, however, on a worldwide basis, 1.2-1.3 tons of bagasse (moisture-free basis) are produced per ton of cane sugar produced. Using conservative estimates, 3.5 MT of whole fresh bagasse (moisture-free basis) or 7.0 MT of fresh bagasse at 50% moisture content, after allowing for depithing, storing and handling losses, are required to produce 1MT of high-quality bleached chemical pulp.

Developing countries usually import pulp and different kinds of papers from countries like Canada, U.S.A., Sweden, Finland and Norway, which produce large quantities of pulp, newsprint and Kraft liners, making use of their abundant forest resources, especially coniferous wood. In this way, developing countries spend considerable amounts of foreign exchange for importing pulp and paper. Owing to the increasing cost of the resources (materials and labour) required to process pulp and the ecological limitations on the exploitation of forest resources and other considerations, there is a need for every country to become self-sufficient so far as the requirements for pulp and paper are concerned. Therefore, most non-wood fibre mills in operation today or being planned for the future are located in tropical and subtropical countries where sugar cane and similar crops are abundant. In fact, there is ten times more sugar produced in developing countries than in developed wood-rich countries. Unfortunately, in some countries most of the bagasse produced at present is burnt in the sugar mill as fuel to generate steam. Thus, in order to utilize the abundance of agricultural residues and non-conventional raw materials, some countries like India have introduced various incentives for established bagasse mills e.g. any mill using more than 75% bagasse in the furnish is totally free from duties. This has encouraged many mills to use a higher percentage of bagasse in the furnish.

However, according to J.E. Atchison [1.1], it must be taken into consideration that although experts agree on the increasing role of non-wood fibres in the pulp and paper industry, the mere fact that a plant fibre can technically be converted into pulp and paper is not an indication that it can be grown, collected, stored, and processed economically enough to make this operation viable. Very few in fact, satisfy the following conditions, which must be fullfilled to ensure the satisfactory operation of a paper mill based on plant fibre:

-An adequate supply of the raw material;
-Available to the pulp mill for the whole year;
-It should not deteriorate easily in storage;
-The raw material must be concentrated in a small area;
-Low-costs for collecting and transporting the raw material to the mill;
-Adequate supply of labour available in the area;
-Low-cost pulp processing giving a high yield of a fibre and a high quality;
-Sufficient demand for the product at a price that will insure profitable operation.

I RELEVANT TECHNICAL PAPERS ENCLOSED:

Environment Aspects in Processing Bagasse for Pulp and Paper Manufacture

RAO DR. N.J.*

1. INTRODUCTION :

The world paper production is expected to grow to 227.341 million tonnes in 1989 from 212 467 Million tonnes in 1984. The average growth rate is likely to be 1.4% per annum while the developing countries will register a growth rate between 2.3 to 3 0% in this period.[1] In India the paper production capacity is likely to grow to 4.25 Million tonnes by 2000 AD from the current capacity of 2 6 million tonnes in 1986. Non wood pulping capacity will grow at a faster rate than wood pulping capacity. The over all leaders in non-wood plant fiber are PR China, India, Taiwan. Mexico. Cuba and Italy. Among many agricultural fibres used for pulping making, sugar cane bagasse stands out more than any other. By 1990, it is expected that bagasse may contribute about 2 %. of total paper making capacity in the world. The developing wood poor countries have ten times more sugar cane than developed countries[2]. Nearly 15 MT af wet whole bagasse is produced annually in the sugar mills. It is expected that 39.2 MT of bagasse will be available by 2000 A.D. A paper capacity of 0.75–1 MT likely to be sustained by bagasse available in India.

Bagasse is composed of three principal components : (a) The rind fibres including epidermis, cortext and pericycle (b) The fibre-vascular bundles comprising of the thin walled rather short fibres with narrow lumen (c) Ground tissues (Parenchyma tissues) or pith fibre bundles distributed inequally. The portion of pith fibre bundles and epidermis (Rind fibres) vary considerably with age of stem, and the sugarcane variety. The fibre content of whole bagasse is around 65 %. piths around 30 %. and solubles around 5 %. The cold water solubles, hot water solubles, Alcohol benzene solubles and 1 %. NaOH solubles in bagasse are nearly 5–8 %., 7.4 % and 41 %. respectively Bone dry bagasse has small quantities (upto 5 %. sugar.

Bagasse is a renewable fibre with large supplies, does not need cutting into pieces like wood, requires less refining power, has less lignin (19 %.) requiring less chemicals, has lesser quality of cellulose content (54 %.) is short fibred (dia 20/μm, length 1.7 mm) and is more hydrated requiring more steam for drying. Pith nas no fibre and is a major disadvantage requiring its removal before cooking. Pith is highly absorbent and hence impurities are deeply absorbed and cannot be easily removed. This requires drastic cooking and bleaching needing more chemicals. If pith is not removed the paper will have more dark shining specs. Pith has a tendency to gel and turn gelateneous with caustic cooking and hence causes clogging of felt and wire and reduces drying rates. It results in the low strength. The pentosan contents are highest (30 %.), ash content (4 %.) is more than wood, but comparable to non woody plants. Bagasse has no resin acids and a lower contents of extractives than wood which is further reduced during bagasse has no resin acids and a lower contents of extractives than wood which is further reduced during bagasse milling and wet bulk storage[3].

The environmental aspects on bagasse utilization for paper making can be seen as under :

- The morphological characteristics and Chemical composition suggest that bagasse cooking and bleaching are more easy than wood pulping.
- Kraft processes with lower sulphidity can be used with reduced aggressiveness of atmospheric emissions in larger mills.
- Soda process can be used with no aggressive gas emissions in small mills.

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— Absence of resin acids, removal of extractives in storage, non-presence of Sulphuric soda cooking liquid effluents. Lower sulphur in Kraft liquid effluents, lower volume of bleach effluents with lower Chlorinated compounds.

The above factors indicate the advantage of bagasse as a better material for paper making from environmental aspects. The environmental aspects are in various stages of processing are discussed.

2. Bagasse Handling and Storage :

Different combinations of depithing storage and handling are practiced by mills loose and baled bagasse are transported. Bagasse is stored in pyramid shaped piles with space between pills. The out side of the stacks are treated with a preservative like boric acid and stack is covered on top with asphalt coated sheet metal. In Ritter Biological treatment Process[4], the bagasse is mixed with biological fluid is conveyed to an elevated channel and then flushed down to a special storage slab. The biological fluid consists of lactic acid bacteria cultured in a 2 5% molasses solution. The liquor is drained and recycled. Biochemical action loosens the pith In bulk storage water or micro-biological liquor spray is used to control the degradation and temperature rise. The effluents from water spray system are more contamined than from microbiological spray system as shown in table—1.

TABLE—1

Effluent Characteristics from Water Spray and Microbiological spray water system in bagasse storage[5]

	pH	COD	BOD	TS	SS	DS
			kg/t bagasse			
Water Spray	4 8	51.8	32	27	17	26.6
Microbiological system	5 0	5 4	2 8	3 99	2 1	3.8

The colour of the effluents is between 405 mg/l for microbiological system while the figure is around 625 mg/l in water spray system. The BOD/COD ratio is high indicating easy biodegrable nature of effluents. In well manage system using microbiological system, the amount of water required can be reduced to about 1m³/t moist bagasse from the normal values of 4m³/t³. Periodic spraying during formation of bagasse piles to raise compactness, avoiding temperature rise beyond 40°C, good water distribution and recycling can improve fibre quality and reduce pollution load.

3. Depithing of bagasse :

The depithing methods are dry, moist or wet. In dry depithing human shredders or other disintegrators remove pith from bagasse with 15—20% moisture. The fiber losses are high, dust problem is severe causing bagasses is an occupational hazard. The process is almost obsolete.

In moist depithing, wet bagasse with about 50% moisture is disintegrated. Nearly 60–70% pith is removed. In wet depithing, bagasse of 2–2 5% consistency is defibrated with 80–84% pith removal. The depithed bagasse is delivered at 20% consistency while pith is thickened to 40–50% by dewatering. This method eliminates other impurities like sand, colloidal particles and organic solubles. Wet depithing can use open or closed system. Dissolved organics from depithing is high if bagasse comes from storage with biological liquor recirculation since the bagasse is washed less intensively than with open water control.

The discharges from bagasse preparation section are shown in table-2. The release of BOD_5 from a well controlled bulk storage is of the order of 20–25 Kg/tonne 90.% pulp. In an ordinary pile storage system the release may be upto 50-60 Kg/t bagasse. The discharges range 10–60 m³ water/t pulp.

TABLE—2

Approximate discharges from bagasse preparation operation[6]

Operation	BOD_5	COD	SS
	——kg/t	bagasse Pulp—	—
Storage dewatering and depithing	20–40	60–240	200–400

Since the dissolved organic solids mainly consist of low molecular weight carbohydrates and acids; and BOD/COD ratios are high, biological treatment aerobic or anaerobic is expected to yield good result. Suspended solids are small and relatively light. Mechanical treatment like sedimentation basin and dewatering filter can reduce S.S. The biological sludges have good sedimentability. The high organic contents without the presence of incompatible substance make them potentially apt for irrigation.

4. Pulping of Bagasse.

Bagasse can be cooked by many methods to give a variety of finished products. The most common chemical cooking is using soda a Kraft process in batch or continuous digesters. The yields are of same magnitude as hardwoods. The cook is very short with low alkali demand and pulp yield is fairiy low. Various modification to these processes are available like Cusi, Peadco the bleached yields are around 45%. Mechano-Chemical Processes using soda or lime produce corrugating medium with high yield.

Mechanical and thermomechanical processes produce high yield pulps for use as newsprint furnish. In these processes the refined pulps are bleached to desired brightness. There are several variations to this. The TNPL mill uses SPB-Beloit process with 85–100% blending of bagasse for newsprint production with mechanical pulp from TMP and CTMP lines and chemical pulp (7,8,9,10).

In mechanical pulping 2.5-10% substance, (low molcular carbohydrates, lignin and extractives) is dissolved. The yield loss in Chemi-Mechanical processes in 5–15%. The higher is the chemicals charged and the treatment temperature and the longer the time, the more substance is dissolved, a main part of the dissolved material is discharged as effluent. A decrease is yield results in an increase in pollution parameters. BOD and COD follows a straight line relation with pipe yield with minor deviations.

Spent liquors from Chemical/semi-Chemical pulping contain largest amount of dissolved organics. A portion of the organic component in spent liquors volatile and is released during blow. For normal washing efficiencies (85–98 ./) the BOD_5 following the pulp may range from 90 kg/t (Sulphite–Viscose) to below 5 Kg/t pulp (high yield sulphate). For mills with no recovery the BOD load ranges from 200–600 Kg/t. The total amount of BOD_5 in digester and evaporator condensates range from 10–70 Kg/t. The liquor carry overs, foaming drastically increase the BOD values.

In the sulphate and soda pulps lignin, hemi-celluloses and some cellulose are degraded and dissolved. About 20 Kg/t of Carbohydrate is present as high molecular material in B. L. and the rest is degraded. All substances contributed to COD value. The colour of of the spent liquor is high due to high molecular lignin fractions. The main source of BOD is the degraded low molecular degradation products of lignin (phenols, phenolic carboxylic acids, vanillar and derivatives, methanol, ethanol). Organic sulphides, terpenes, methanol and ethanol are present in the volatile components of BL and condensates of digester and evaporators. Almost similar material is present from soda process with less organic sulphides.

The BOD, COD and colour values of organic substances dissolved in chemical sulphate and soda pulping of bagasse is given in table-3.

Table-3 :—The BOD_7, COD and Colour of the Organic substances dissolved in Soda and Sulphate pulping of Bagasse[4]

	Pulp yield ./·	Kappa No.	BOD_7	COD Kg/t	Colour 90
Soda Pulping	80	—	265	750	—
Sulphate Pulping	48	15	350	1340	950

The main part of water pollution originates from spent black liquors, and this depends on yield. Some typical figures for total black liquor content expressed as BOD_5 for bagasse pulps is given in table–4.

TABLE—4

Black liquor BOD Vs. Yield[11]

Process	Cold Soda	Kraft	NSSC
Yield, ./·	80	48	70
BOD_5/t Pulp	150	350	200

Better washing, retention of spills and other inplant Measures can reduce Pollution load.

5. Washing, Screening and Bleaching :

Bagasse has higher hydration as compared to wood and bamboo and hence has slow drainage. The loading factors are low(0.5-4 t m² day) requiring larger surfaces for filteration. The washing is normally performed in 2-4 drum filters in series (counter current operation). The slow drainage results in a practice of rather high dilution factors for non wood pulps e.g. 3-6 m³/t pulp compared to 1.5 — 3.0 for wood pulps resulting in weak black liquors with low solids contents (11-13 %. or even lower). Washing losses decreases (efficiency increases) with increased dilution. The pollution load washing comes foaming and spills. The BOD values from this section range from 25-80 Kg/t pulp depending on washing efficiency.

Centrifugal screens are used to remove extraneous matters like sand, dirt etc. Traditionally 3 stage-CEH sequence is used for bleaching non wood pulps. Chlorine consumption is between 3.5 -5 %. based on moisture free unbleached pulp. Chlorine (Chlorine dioxide, Hypochlorite) and alkali removes the dark coloured lignin residues. In peroxides and dithionite bleaching low molecular compounds (acetic acid) gets dissolved with BOD discharges around 10-30 Kg/t. In case of TMP/RMP pulps, the dissolved solids increase with increase in the charge of peroxide and alkali. The colour of the effluent is linearly related to the amount of lignin dissolved which is directly proportional to the amount of lignin, in original pulp.

Chlorine charge, alkali charge, pH and temperature influence the pollution load. In bleached soda/sulphate pulps, there is little variation in BOD (14-16 Kg/t) and COD (60-80 Kg/t) for different species, but colour variations are significant (70-100). The chlorine bound to organic molecules in bleach plant effluents are significant as they show a slow degradation biochemical oxidation and tend to accumulate in organic tissues. The substitution of chlorine by chlorine dioxide and oxygen, organic chlorine reduced from 13 Kg/t to below 5 Kg/t besides reducing BOD (upto 35 %) and colour (upto 75 %). These process modifications require changes in processing equipment and will increase investment and operating costs.

The characteristics of individual waste waters from typical Indian small mills using bagasse and straw without chemical recovery is shown in table—5.

TABLE—5

Characteristics of Individual Waste waters from a 23 TPD mill using bagasse and straw Soda process without chemical recovery (12)

Section	PH	Alkalinity $CaCO_3$	TS	SS	BOD	COD
			mg/l			
BL	9.5	1570	68930	2340	10200	53600
Pulp Wash	9.2	940	14440	1850	2450	8800
Bleach	6.8	210	3640	440	290	1020
Paper m/c	6.9	130	1200	480	180	580
Combined effluents	7.5	510	3230	850	330	1100

From towers and fillers residual chlorine and chlorine dioxide are vented ranging from 1-3kg/t (as chlorine).

6. Stock Preparation and Paper Making[49]

Bagasse stock is well hydrated with slow drainage characteristics. It normally requires less rosin size and more alum than conventional wood fibres. Modifications in machine design are required to improve drainage. Due to low wet web strength closed draws like suction pick up are necessary to transfer the web from the wire to the press part. The wire part should be longer with modern drainage elements like multiple blade foils systems, more suction boxes. The felts should have high porosity. Felts tend to clog due to higher amount of fines. The drying curve for bagasse furnish is greatly flattened compared to conventional fibres requiring more drying surface.

The white water system from paper machine needs closure. The pollutants consist of SS (fibres, inorganic fillers), DS (non-wood plant components, additives). Closing white water system reduces fibre loss and water consumption. With complete open system fibre loss is as high as 50-150 Kg/t with partial recirculation this can be brought down to 25-50Kg/t paper Further white water system closure is possible[13] The white water discharges in such a case are 10-50m³/t. with fibre losses in the range of 5-25 kg/t. This requires advanced internal measures. White water system closure is limited due to deterioration in quality (build up of DS) leading to reduced retention, slower dewatering foaming, bad sizing, picking, linting, deposits on machine components and even deteriotation of paper strength and printability.

In the paper mill the dissolution of fibre material occurs at refining stage (2-4% in high yield pulps and negligible in chemical pulps) with a BOD_5 load of 1-5 kg/t. The discharge of BOD load is not effected by systems closure. The external treatments like sedimentation basin or biological treatment or chemical flocculation should be used in addition to system closure to reduced BOD loads.

The cylinder mould machines and fourdrinier machines require 1-4m³/t pulp shower water. The effluents from this section can be reused. The characteristics of waste water from paper m/c. of a bagasse chemical pulping unit are shown in table—6.

TABLE—6

Characteristies of Waste Waters from Paper Machine Drain[12,14]

pH	Alkalinity	COD	TS mg/l	DS	SS
4.5	44	3435	2352	116.4	1182

7. Chemical Recovery[49] :

The chemical recovery system is similar to the ones used for wood pulping. They consists of counter current brown stock washers, MEE, recovery boilers and recausticization. The major draw backs relate to high silica content (1-3% of dry solids), high viscosity due to higher pentosans and lower heat value due to lower lignin content and higher carbohydrate content resulting in lower carbon content. Bagasse B.L. is not as foamy as wood B. L. Due to difficulties in washing bagasse pulp, larger amount of water is used giving higher sodium losses, decreased recovery efficiency and reduced total solids in weak Black Liquor. High silica is transferred to lime mud as calcium silicate during recausticization. This reduces the efficiency of lime mud recovery and decreases CaO content of lime produced by reburning.

A relatively high concentration of free alkali (at east 8 gpl of NaOH) in weak B.L. can be maintained by adding white liquor before evaporation. A low storage time for BL, as constant as possible temperature profile throughout evaporation, low fibre content in BL through installation of fibre fillers before evaporation, good periodical washing including a spare unit for final effect can improve performance. The evaporation is carried out in 4–5 effect long tube vertical raising film evaporators. The first bodies get plugged by organic matter, Ca-Carbonate scales stay in middle effects and silica as Aluminium silicate remain in last bodies. To reduce serious silica scaling the dissolved solids concentration at outlet of evaporators is limited to 35–40%. It is then further concentrated in direct contact evaporators to 55–60%.

The chemicals are recovered from furnace as smelt and dust of Na_2CO_3 in soda liquors. In Kraft process conventional Tomlison type boiler is normally used. 10–20% lower heat value of bagasse B.L. require supporting oil firing. To achieve proper liquor droplet distribution, liquor pressure at the gun is kept substantially higher than for conventional liquors. In some cases steam shattering may be utilized. The thick black liquor lines may require steam tracing as they may get stuck at lower temperatures. The BL tank needs indirect steam heating. The furnace design particularly dimensioning, tube pitch, scope for soot blower and possibility of hand lancing need to be considered to ensure that ash generated does not deposit on tubes as it is very difficult to remove. The spout for removing smelt should be short and properly inclined with high furnace bottom temperature. As the risk of building up deposits on boiler tubes partly depends on tube metal temperature, it is favourable to select low boiler pressure and low super heat (below 400°C).

The smelt after dissolving is clarified and mixed in a slaker with lime and goes to causticizers and white liquor clarifies. The sludge is thicknenced and disposed off. In causticization, the silica is transferred to lime mud making reburning difficult.

The steam condensates from stages other than the first are usually contaminated with methanol and other sulphur compounds. The odourous gases from kraft mills are chiefly H_2S, M.M. and organic sulphides. Soda mills have very little sulphur except when lime reburning is practised. The amount of odourous gases emitted from evaporation plant is 0–1–1 Kg S/t, TRS from DCE range 80–500 ppm. This can be reduced with black liquor oxidation. B.L. in DCE serves as an absorber both for SO_2 and Na_2SO_4. Cascade evaporator removes 15% dust. Evaporator scrubbers reduce SO_2 emission by 50–80% and dust emissions by 15–25%. The range of total emissions from recovery department are exemplified below.

TABLE—7

Emissions from Recovery Section.

	T RS Kg S/t	SO_2 Kg/t
Evaporation	0–2	—
Recovery Boiler	0.1 –4	0 2–4
Causticizing	0.02–0.2	0.2

Water pollution from evaporation is contaminated condensates and spills, from racovery boiler spill and from causticizing due to lime mud, grits, dregs and spills. Evaporator cleaning, carry over from separators add to pollution. The range of total discharges to water from recovery department are as shown in table 8.

TABLE—8

Effluents from Recovery Section

	BOD	COD	SS
		Kg/t	
Evaporation	10–30	15–80	—
Recovery Boiler	1	5	1
Causticizing	—	10	5–250

Malodourous gases can be treated by dilution scrubbing. Dust emissions can be controlled by proper EPS operation.

8. Pollution Control Strategy[**]

The fibrous materials used in Pulp and Paper Industry has components like lignin, hemicelluloses, sugar, alcohols, organic acids and inorganic acids part of which are not reclaimed or recycled and are discharged to receiving waters or atmosphere. Similarly process chemicals cannot be entirely recycled. A small fraction of good cellulose fibre is also lost. Pollution abatement is started with intcenal as well as external measures. The capacity of the receiving body to cope with discharges has to be estimated.

The potential effluents (particulates, gaseous emissions, water effluents and solids) and their sources need to be identified for proper internal measures. The situation is serious when mill, particularly small ones do not have recovery systems.

8 1 Internal measures.

The discharge of dissolved organic substances in mill with chemical recovery in a bagasse based mill can be reduced with measures in following order of priority.

— Improved Washing efficiency.
— Reduced Spills of black liquor,
— Treatment and reuse of selected cooking and evaporation condensates.

It is possible to improve washing efficiency by adding one additional washing unit when efficiency is in the normal range of 75–90% compared to external treatment. The following measures can improve performance of existing units significantly.

— Operate to washing at as constant pulp flow as possible with no over loading.
— Keep dilution factor constant.
— Keep Kappa number of pulp constant.
— Keep wash water temperature constant in the range of 65–75°C
— Keep proper distribution of wash water over the whole filler.
— Minimise dilution of B.L. by addition of sealing water etc. through good maintenance and control.
— Avoid spills by controlling uneven production rates, equipment breakdown, proper buffer volume, good house keeping and avoiding human errors.
— Spills should be properly collected in dump tanks.
— Contaminated condensated be treated separately with steam stripping.
— The SS solid emissions from treatment of bagasse can be checked by separately pretreating the effluents in sedimentation units. Otherwise they represent a large BOD load.
— Fibre losses in excess white water can be checked by increasing degree of closure and condition of wires.

The excess white water ranges from 100–200m^3/t can be reduced to 10–50 m^3/t by system closure.

— Proper operation of ESP can keep the dust emissions under control from recovery.

— Proper functioning of dust extractors can reduce dust from bagasse handling sections.

The total result of internal measures are illustrated in table–9.

TABLE—9

Emission of BOD, SS in Kg/t from bagasse Pulping.

	Raw material		Washing		Recovery		Bleaching		Spills		Total	
	BOD_5	SS	BOD_5	SS	BOD_5	SS	BOD_5	SS	BOD_5	SS	BOD_5	SS
A. Without Recovery	50	100	300	20	—	—	10	5	—	20	365	145
B. With Recovery 85 % washing Efficiency	50	100	45	20	10	290	10	5	15	20	115	365
C. With Recovery 95 % washing Efficiency Condensate taeatment special recovery system.	50	100	15	10	5	220	10	5	3	5	83	340
D. C. above plus External primary and secondary treatment											15	40

As can be seen in the table, raw material handling represents a considerable share of emissions of both BOD and SS. Large amount of SS are emitted as inorganic substances from recovery department. Only a minor part of the suspended solids is represented by fibres and fibre fragments.

8.2 Large Mills with Chemical Recovery[49].

The large mills have chemical recovery. The gaseous emissions from Kraft/Soda mills contain Mixtures of SO_2, H_2S, Dimethyl Sulphide, Dimethyl disulphide and methyl mercaptan. The sources include Recovery furnace, DCE, digester relief and blow, Lime Kiln, MEE and smelt dissolving tank. The Soda pulping system has practically no sulphur emissions. The main emissions of TRS compounds are shown in table—10.

Table—10

Main Emissions of Reduced Sulphur Compounds from Sulphate/Soda pulping[a] (kg S/t_{90})

Emission	H_2S	CH_3SH MM	CH_3SCH_3 DMS	$CH_3 SCH_3$ DMDS
Digester, Batch	0-0.15	0-1.3	0.05-3.3	0.05-2.0
Continuous	0-0.1	0.5-1.0	0.05-0.5	0.05-0.4
Washing	0	0.05-1.0	0.1-1.0	0.1-0.8
MEE	0.05-1.5	0.05.0.8	0.05-1.0	0.05-1.0
Recovery furnace with DCE	0-25	0-2	0-1	0-0.3
Recovery furnace without DCE	0-1	0.01	0.01	0.01
Smelt Dissolving tank	0-1	0-0.08	0-0.5	0-0.3
Lime Kiln	0-0.5	0-0.1	0-0.1	0-0.1
Settling Basins	0-0.5	0-0.02	0-0.01	0-0.02

The bleach plant is likely to emit Cl_2 (0.1-3kg/t), ClO_2 (0.1-1kg/t) and SO_2 (0.1-1kg/t). The SO_x and NO_x emissions are likely from recovery furnace, lime Kiln and smelt dissolving tanks. Water vapour emissions range 5-8 t/t pulp. Particulate emission come from recovery furnace, lime Kiln and smelt dissolving tank. The dust is mainly Na_2SO_4, and Na_2CO_3. Particle size range from 0.1/μm to 10μm for uncontrolled emissions and from 0.1um to 10μm for controlled systems The emission rates are highest after DCE (7-60 kg/t or 900-5000 mg/m³).

The waste waters come from digester. house leaks, spills of BL, gland cooling water pulp washing, decker washings centricleaner rejects with high concentration of fibres and grit, bleach plan effluents of low pH with chlorolignins, Caustic extraction effiuents of high pH and colour, white waters with fibres and talc, foul condensates. The combined waste water volume ranges 214–352 m³/t paper with pH between 6.5-11.8. The dark brown colour is due to lignin derivatives The charateristics of combined waste waters are shown in table–11.

Table–11 : **Characteristics of waste waters**

Volume, m³/t Paper	305
S S Kg/t	131
BOD_5 Kg/t	51
COD/t	217
% Na	47

Since bagasse has no resin acids, the toxicity is expected to be low.

The solid wastes come from bagasse handling (42 Kg/t), lime mud from causticization (500–600 Kg/t), ash (1.3 t/t) from boiler, Solid/semisolid wastes from centricleaners (10 kg/t) and primary settling waste (26 kg/t).

8.3 Small Mills without Ckemical Recovery[49]

The Small Mills use lime/soda as cooking chemical. CEH blerching sequence is mostly followed. There is no chemical recovery due to economic reasons. Waste waters are generated from BL, pulp washing, beaters, bleaching section, thickness and paper machine. The paper machine waste waters are recycled to varying degrees in pulp washing (42–157 m³/t, av 71 m³/t).

Black liquor is the most polluting stream and contributes nearly 80% of the pollution load. Only a few mills use counter current washing in two stages. Paper machine waste water is least polluting but has appreciable SS. The characteristics of combined waste waters from small mills is shown in table–12.

There is appreciable variable in flow and characteristics of waste waters from different mills. The BOD load of a kraft mill with chemical recovery is 50 kg/t paper against 176 Kg/t paper for small mills with no recovery i. e. nearly 3–5 times more polluted. The sodium absorption ratio (SAR) and percent sodium values of combined waste waters are high in mills where unbleached papers are made using soda process. The values of SAR ranged between 3.5 to 7.6 (in most causes between 3.5 to 5.5). If the proportion of Ca to Na can be increased, the combined waste waters can be used for irrigation after suitable dilution to keep TDS and BOD within recommended range.

Table–12 : Range and Average Characteristics of combined waste waters based on Agricultural Residues (based on 7 mills, 7–30 TPD capacity)[12].

		Mills with no chemical recovery		Mills with chemical recovery*	
		Min	Max	Ave	(14)
Volume, m³/t paper		187	383	252	455
pH		6.0	8.5	—	5.6–6.3
SS	mg/l	400	1115	615	816
	Kg/t	88	239	155	371
BOD_5	mg/l	220	1067	698	350
	kg/t	85	267	176	159
COD	mg/l	2120	4563	2940	1275
	kg/t	497	741		581
Lignin	mg/l	320	700	563	—
	kg/t	93	197	142	—
Sodium	mg/l	200	548	398	—
	kg/t	48	142	98	—

* Bagasse Chemical Pulp (Soda)

The non biodegrable fraction of COD is high and is mainly due to lignin in BL making its reduction difficult by biological treatment. Thus colour removal may have to be tried chemically. Nitrogen and phosphorous contents are lower than required for biological treatment and hence these are to be supplemented.

The solid wastes are generated from material handling (440–660 kg/t). rejects, primary and secondary sludges from waste water treatment systems (220 kg/t) and coal and boiler ash (1–3t/t), Small mill handle on an average 0 6 t/t organic solid wastes.

The air pollution problems are negligible. Digesters release about 1.4 t steam/t pulp alongwith organic volatiles. There could be particulates from boiler house.

Only a few small mills have primary and or secondary treatment facilities.

8 4 External Measures[49] :

At first a pretreatment is done to remove grit, debris and floating materials. The primary treatment of contaminated common waters to reduce discharge of SS to recipient is generally recommended. Sedimentation, some times with flocculation (by Alum) in rectangular clarifiers with a surface load of 0 6–1.0 m/h (m^3/m^2h) and depth of 4–5 m is widely used. The sludge should be removed. The resulting effluent has less than 20 mg/l SS (70% reduction) and BOD is reduced by 25–50%.

Biological treatment is most common secondary treatment method in Pulp and Paper industry. This reduces the soluble organics. There are several biological treatment methods in use These are anaerobic lagoons, activated sludge systems, oxidation ponds. The fundamental characteristics of different methods are approximately same. Biological waste water treatment processes utilize a mixed population of micro-organisms which convert the dissolved organic matter to new cellular material. Aeration time and temperature are important in their operation.

Anaerobic lagoons with a detention time of 20–22 s reduce BOD level from 800 to 90 mg/l (80–90% ...tion). Aerated lagoons need large land area with ...ys retention and can remove 80–90% BOD reduction. Trickling filters can reduce 40–60% BOD Activated sludge process require Nitrogen and phosthorous supplementation at the rate of 4 3 kg and 0 6 kg respectively for every 100 Kg BOD removal. Nearly 90% BOD removal is possible by this method. Sludge dewatering requires careful consideration in all these methods.

Colour removal and final polishing can be achieved by absorption. However no commercial scale installations exist. The table 13 shows the summary of the pollution control methods used in mills.

TABLE—13

Summary of Pollution Control methods used in Paper Industry[15]

Section	Method
Raw material handling and Storage —	Reduced water consumption by recycling. After removing SS, combined effluent goes for treatment.
Chemical Pulping —	Water recycling. Improved washing and screening. Prolonged cooking, O_2– prebleaching use of ClO_2 in 1st bleaching stage. Separate treatment of contaminated condensate prevention of accidental losses, use of scrubbers to reduce TRS and SO_2.
Mechanical/CMP —	Closure of water system, Reduction of discharges of rejects, control of accidental spills.
Paper Making —	Closure of white water system. Use of efficient saveall, efficient fibre recovery.
External Effluent Treatment —	Pretreatment, Primary treatment (Sedimentation with or without chemical) to reduce SS, BOD Secondary treatment to reduce BOD toxicity (Stabilization pond, aerated lagoons, ASP, Trickling filters, anaerobic treatment)

Section	Method
Bleach Plant Effluents —	Chemical treatment with lime, Anaerobic/aerobic treatment, Adsorption, with Aluminium oxide, ion-exchange, UF - They reduce colour, COD.
Sludge Dewatering —	Dewatering of sludge (Thickening, mechanical dewatering by vacuum filters, presses, belt filters press), Incineration, composing or land fill of sludge.

A flow sheet for water treatment plant with primary and secondary stages is shown in Fig. 1

In small paper mills without chemical after flow equalisation, the combined effluents are sent to a primary clarifier with sludge drying. For anaerobic systems nutrient addition is made such that BOD: N:P is 100:2:0.5. For aerobic system it is 100:5:1. The alternative secondary treatments are shown in table 14.

TABLE—14

Treatment Alternatives for Small Mills without Chemical Recovery[12]

Equalisation of flow, Primary clarifier and sludge drying preceed the treatment

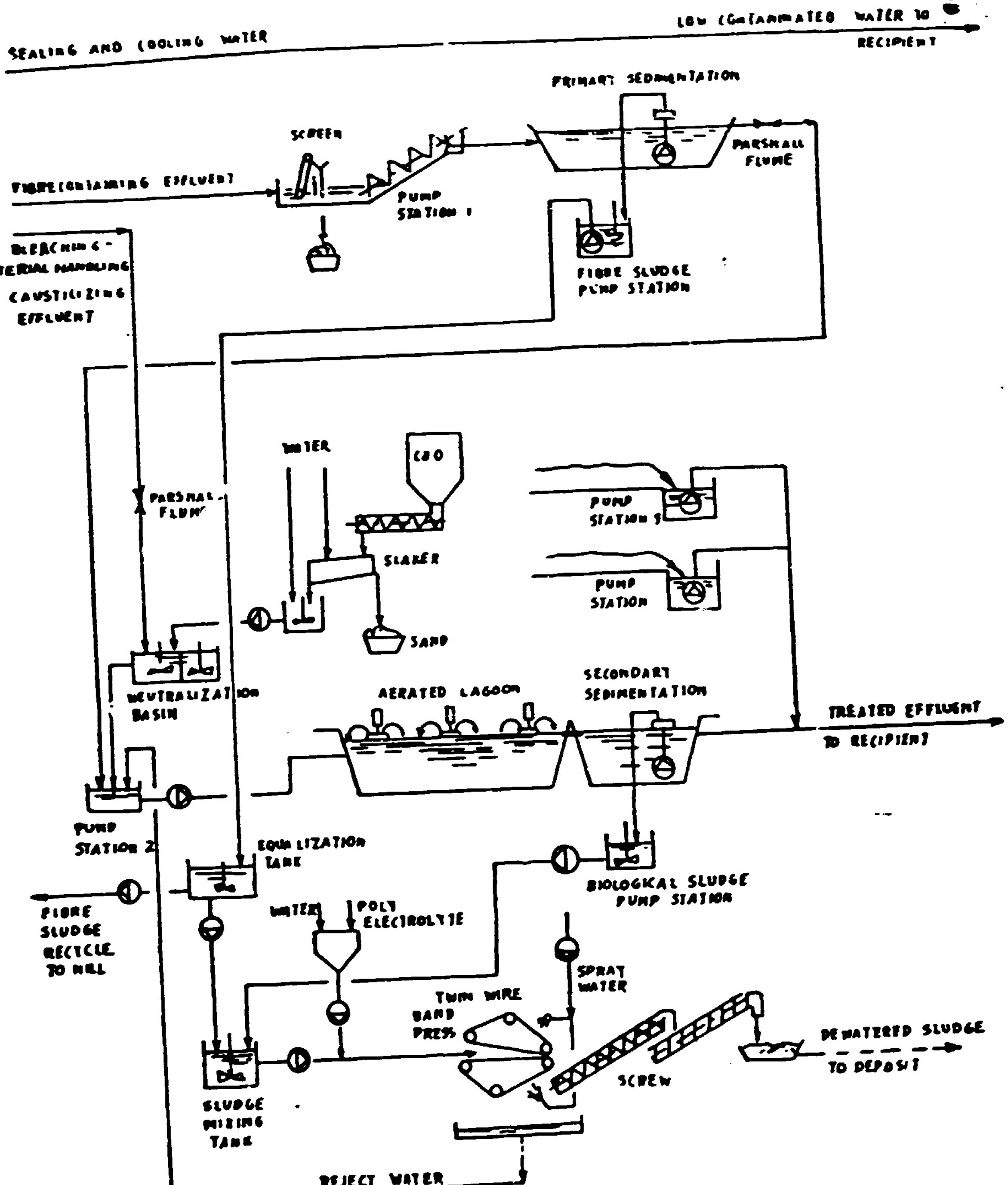
Alternative							Treated effluent mg/l
1.	Nutrient Addition	Anaerobic Lagoon DT-20 D (Reduce foaming)	Aerated Lagoon DT-4 D	Polishing Pond DT-2-3 D	SS BOD_5 COD	— —	30 40-50 1000+
2.	—do—	—	6DT	3-5D	SS BOD_5 COD		50-60 30-50 100+
3.	—do—	—	Oxidation Ditch (Foaming Problems)	SST Sludge Drying	SS BOD_5 COD		20-30 30-50 1000+
4.	Anaerobic Lagoon DT-25D	Nutrient	Aerated Lagoon DT-4D	Polishing Pond DT-4D	SS BOD_5 COD	— —	30 40-50 1000+
5.	Aerated Lagoon DT-6D	SST Sludge Drying	—	—	SS BOD_5 COD		50-60 30-50 1000+

The industry will strive to use a combination of suitable technology, inplant measures and external treatments to reduce pollution loads of the effluent streams.

9. Pollution Abatement and Control Tehnology trends :

The pulp and paper industry will concentrate on various means of reducing pollution loads from being generated and will control them to acceptable limits. An excellent review of current trends is available[15].

The pollution load arises from material handling and storage, pulping (Chemical/Mechanical), bleaching and papermaking. The treatment of pollutents in addition to inplant measure like closure of water system, reduction of discharges of rejects, control of accidental spills, includes external treatment methods.


SEALING AND COOLING WATER
LOW CONTAMINATED WATER TO RECIPIENT
PRIMARY SEDIMENTATION
SCREEN
PARSHALL FLUME
FIBRE CONTAINING EFFLUENT
PUMP STATION 1
FIBRE SLUDGE PUMP STATION
BLEACHING - MATERIAL HANDLING CAUSTICIZING EFFLUENT
WATER
CaO
PARSHALL FLUME
PUMP STATION
SLAKER
PUMP STATION
SAND
NEUTRALIZATION BASIN
AERATED LAGOON
SECONDARY SEDIMENTATION
TREATED EFFLUENT TO RECIPIENT
PUMP STATION 2
EQUALIZATION TANK
BIOLOGICAL SLUDGE PUMP STATION
FIBRE SLUDGE RECYCLE TO MILL
WATER
POLY ELECTROLYTE
SPRAY WATER
TWIN WIRE BAND PRESS
DEWATERED SLUDGE TO DEPOSIT
SCREW
SLUDGE MIXING TANK
REJECT WATER

The aim in next decade will be to go in for zero effluent discharges[16] and total recycle concept. This can be achieved by choosing proper technologies which increase yields, use chemicals which are less polluting and toxic, adopt more recycling techniques and convert wastes to wealth. A brief description is given below of the likely trends in the years to come which will have a significant impact on reducing and controlling pollution.

9.1 Pulping Bleaching :

— The trend towards high yield pulping (TMP CTMP) will increase reducing dissolved solids in effluent streams.

— Use of organosolve process[17,18,19] with different alcohols or phenol or ammonia-Ketone solvents to reduce water pollution and help recover lignin.

— Use of bio-pulping methods hold promise for abating pollution arising out of chemicals[3]

— Use of oxygen delignification[20] continuous cooking with high pressure impregnation, use of Antroquinone and polysulphides to increase yield are likely to reduce pollution load significantly[21].

— Holopulping at atmospheric pressure by using selective delignification oxidants like ClO_2 is likely to give 70% yield, reduced odour and pollution load with possibilities in chemical regeneration.

— Explosion pulping of bagasse using soda at 200°C and 13.8 MPa. N_2-pressure and explosive discharge through multiple bar nozzles reduces alkali consumption by 30–40%, improves drainage and reduces pollution load[22].

— Vapour phase pulping of bagasse, with presoaking with alkali, cooked after removal of alkali at 160°C gives 5% more yield than convention liquid phase cooking. The volume of liquid effluents is reduced by half and had a COD of 992 kg/t against COD of 1964 Kg/t in conventional liquid phase pulping[23].

— Use of peroxide, oxygen, nitrogen peroxide and ClO_2 in place of Chlorine in bleaching [20,24] use of multistage counter current washing can reduce pollution loads.

— Use of green liquor sulphite process with high available alkali for agri-residue will give BL with less silica and help in recovery[26].

— Use of combination of counter current washing with recycling and purification by an adsorption resin can reduce pollution load significantly. Similarly modifications in conventional multistage bleaching sequence for recycling the effluents by UF/RO technology will reduce pollution load[26].

Changes in bleaching sequences can reduce pollution.

9.2 Chemical Recovery :

— Small mills not using chemical recovery can plan Ferrite recovery process (27, 28). Here BL of 20% conc is burnt with Ferric oxide at 850°C. This gives recovery of chemicals and regeneration of ferric oxide besides reducing pollution load significantly.

— Wet cracking of BL (10% solids) of agricultural residue at 360°C and high pressure (200 atm) in absence of oxygen results in carbohydrate conversion to char powder, organics becoming a gas (mixture of CH_4, C_2H_6, H_2 and CO_2) with possibilities of SO_2 recovery. The process is claimed to be economic and help control pollution[29].

— Desilication process for BL will help in increasing causticization efficiency and Lime mud reburning, thereby reducing pollution[30].

— Black liquor oxidation, changes in evaporator configuration (use of venturi evaporator), wet air oxidation, fluid bed combustion, thin film evaporation, oil flash evaporation[31,32] will help in energy conservation and pollution control.

— Use of UF/RO Technology for Bl regeneration will significantly help energy conservation and reduce pollution[33].

— Possibilities of using BL oxidation to reduce pollution loads and evaporator steam use show promise.

9. 3 Treatment methods :

Anaerobic treatment methods will receive greater attention over aerobic treatment methods for reduction of COD due to the generation of methane gas on one hand and reduced sludge volume on the other[34, 35, 36]. Many commercial alternatives are available. The system is cheaper than aerobic system and is more flexible.

— Application of SO_2 to reduce bleach plant effluent will receive attention[37]. SO_2 Treatment significantly reduced toxicity of C_D EHED, and C_D EDED bleach effluents.

— Use of active carbon beds to remove chlorinated organics adhering to fibres and particles alongwith flocculation, settlement and filteration reduces pollution load[38].

— Use of closed cycle bleach plant effluents will reduce pollution load[21, 38].

— Wet air oxidation of Soda recovery effluents control deposits[39].

— In stream aeration of waste waters[40], recycling and individual processing of selected effluents[4] reduces pollution load.

— Removal of colour by use of dolomite, coal ash[41, 48] use of fungus (Ligninolylic cultures of white rot fungus–Phannerocheate chrysosprium)[42, 43] for bleach plant effluents could be quite successful. Fungal treatment can reduce energy requirements for secondary refining of TMP[13].

— Use of Ca-hypochlorite, Changing CEHH to HCEH or HCEHH bleaching sequence reduced colour by 76% and Pollution load by 40–50%[44].

— Fluidized bed incineration and heat recovery of primary clarifier sludge is possible. Further cleaning of flue gases by multicleaners will reduce the particulates[45].

— Use of hydrogen peroxide (7 to 10 mg/l) can reduce the sulphides from pulp mill effluents to 3-7 mg/l besides reducing odour and sludge volumes[46].

— Effective use of kraft mill effluents after treatment for irrigation is possible[47].

— Possibilities of generating protiens, look promising[3].

— Reduction of dust in bagasse handling and boiler operations will receive attention.

10. Conclusion :

Bagasse is going to be key material for paper making. The processing technology is in for far reaching changes. Pollution abatement and control is going to be an important area requiring attention. There is a need for systematic monitoring of bagasse based paper industry for getting first hand reliable information on pollutants, their characteristics and their effects on environment. The monitoring of gaseous, liquid and solid effluents must proceed as a regular strategy to develop alternatives to achieve minimum acceptable standards. This will require development of new cost effective technologies to reduce pollution.

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Bagasse Based Paper Mills Some Indian Experiences & Financial Aspects

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The growing demand for paper and Board is indicated by the per-capita consumption which is around 2.2 Kg. and in the year 2000 AD it would be 4.5 Kg. This figure wauld appear to be very low when compared to 252 Kg. for U.S A. and 129 Kg. for Japan. The increasing literary, social advancement and industrialisation invites the immediate attention of the industry in this country to grow up to meet this demand. In this context the Planning Commission has estimated that requirement of different variety of paper and boards in the 6th and 7th Plan period as 18,95,000 and 26,45,000 tonnes respectively.

Against the projected demand of over 26,45,000 tonnes of paper & Board by the year 1990, the installed capicity in India has been 18,50,000 tonnes and the atcual production 13,50,000 tonnes. This projects a very wide gap botween demand and supply. This calls for augmenting the production of Paper and Paper Boards by nearly 100% during the next 8 years by creating necessary capacity to meet the demand.

To augment such a capacity, the situation calls for a mammoth effort to mobilise the raw material required to extent of 1,21,50,000 tonnes per annum by 2000 AD

As it could be seen, most of the raw material requirement is met with forest basedraw material, which has resulted in ecological imbalance and has disturbed environmental equilibrium.

SUGAR MILLS-A SOURCE OF RAW MATERIAL FOR PAPER

It has now become necessary to go in for planned afforestation, and collection of other non-conventional raw materials like bagasse, a sugar cane waste of sugar industry and other agricultural residues.

Bagasse is a very promising raw material. because of its availability in sugar mills Collection of bagasse to meet requirements of paper industry does not pose any problem. However, the availability of bagasse at sugar mills is still limited owing to the cautious attitude of the Sugar mills in dispensing with boilers for the reason that the procurement of coal in the country is a big problem. To convince sugar mills to install coal fired boilers, it becomes very necessary to assure sugar mills the availability of coal and the higher thermal efficiency achieved by using coal fired boiler. This would enable sugar mills to release all the bagasse generated in their factory.

It is very essential to install equipments necessary for improving the thermel officiency of sugar mills, so that the bagasse utilization as main fuel for their boilers are considerably brought down, so that the surplus bagasse can be created and spared for paper making. Example is the utilization of waste heat lost through flue gases is used for drying of bagasse, as being contemplated in Mysore Sugar Company, and other progressive mills.

From the economic point of view the concept of installing a paper mill adjoining sugar mills would minimise waste during collection, handling losses during transportation and storage. It is however very important in the national interest that sugar mills will take up the issue of releasing all the bagasse generated by installing coal fired boilers for their steam generation.

REQUIREMENT OF RAW MATERIAL FOR PAPER

The raw materials requirement for the projected capacity will be enormous. The Natinal Commission on Agriculture has estimated the requirement of raw materials for pulp and paper during the years 1985 and 2000 as follows:

	Lakh tonnes	
	Year 1985	Year 2000
1. Bamboo	31.23	35.46
2. Hardwood	30.80	82.04
3. Soft wood	6.46	23.90
4. Bagasse	0.82	7.20
5. Waste Paper, agricultural residues and others	5.38	22.85
Total	74.62	171.45

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1 **Bamboo**

The extent of bamboo utilisation is restricted due to bamboo growing stocks being extensively depleted for one or the reasons like :—

(a) clearance for cultivation

(b) clearance of forest for raising plantations of commercial species like teak etc.

(c) inadequate protections against fire and grazing specially after gregarious flowering.

(d) being a major raw material for paper/pulp making.

2) **Hardwoods**

The extent of hardwood utilization by the year 2000 AD will increase manifold. However the hardwood species present in the national forests, are many and present in intimate mixtures preventing selective fellings. Some of the species are not suitable for pulping. Therefore, replacement of existing valueless growth by raising plantation of fast growing species in a big way is necessary.

3) **Softwoods**

The extent of hardwood utilization by the year 2000 AD will also increase manifold. However, proper and selective fellings are very essential for soil conservation coupled with existing national forest regeneration, which should be protected against evil practices of excessive grazing, till they are established. The basic problem relating to the exploitation of coniferous woods for pulping, is the inaccessibility of mountain regions, where these forests exist. Therefore, it is necessary to develop the infrastructural facilities in these hilly regions, to tap the softwood sources. The timber extraction methodology should be reviewed to include whole tree utilization as an important development for economy measure.

4) **Waste paper**

Waste paper utilisation for paper making is increasing and about 20-25% of raw materials for paper making at present comes from this source. Better efforts are essential to increase recycling of waste paper including de-inking process.

5) **Agricultural residues like straw**

The extent of utilisation of these raw materials by the year 2000 AD should also be substantial. Their availability at present, is restricted because of their secondary usage, poor performance in their collection and transportation costs. Therefore, it is necessary to determine their potential availability and to determine a suitable technology, so that their usage is maximized by the year 2000 AD. With respect to cereal straws like wheat and paddy though the acrage under cultivation is very extensive, their use in paper making is limited because of the follawing :—

(a) Use of straw as a folder for cattle, witch has a priority need.

(b) Scattered and seasonal availability.

(c) Because of bulky nature, increase in cost of collection and transportation from larger areas.

(d) Short fibre quality of the straw.

6) **Bagasse**

The use of bagasse for making paper is extremely desirable, in the present situation of inadequate availability of raw matsrials due to depletion of forest areas. Bagasse can be available from a cluster of sugar mills. It is in this context that Government of India have announced a 100% excise rebate on paper made out of a furnish containing not less than 75% bagasse pulp.

However, bagasse utilisation for paper making, is restricted due to—

(1) its use, as main fuel for generation of process steam in sugar mills, and

(2) the restriction imposed by Government of India on the emergence of new sugar mills, so that the lands used for grain production is not diverted to sugar cane production.

To circumvent these two basic problems, it is necessary to take active steps and planned participation of all concerned so that the extent of bagasse utilisation by the year 2000AD is maximised and thus save forest. The availability of bagasse for paper making by the year 2000AD should be augumented.

Therefore, emphasis is now ~~in~~ improving the potential availability of bagasse for paper making.

BAGASSE GENERATION IN SUGAR MILLS

The total sugarcane cultivating area in India in the year 1979-80 is estimated at 6.6 million acres and the sugarcane produced is 128 million tonnes. This is increasing as sugar demand is increasing.

Around 300 sugar mills are in operation in the year 1980 and crushing 40 million tonnes of sugarcane at an average recovery of 9.88%.

Based on the above, out of 40 million tonnes of sugar cane crushed in sugar mills, about 12 million tonnes of mill wet bagasse is available with 50% moisture. For one tonne of bleached pulp, about 5.5 tonnes of mill wet bagasse is required. About 2.2 million tonnes of paper could thus be produced if all the bagasse is made available.

Sugar Mills have to depend on the bagasse for their fuel requirement and hence part of available bagasse is burnt in the sugar mill bagasse boilers for generating steam, leaving behind the surplus bagasse available for paper making. By improving the thermal efficiency of the sugar mill bagasse fired boiler and by operating at optimum levels it is expected that sugar mills can release at least 10-15% of bagasse additionally for paper making.

SURPLUS BAGASSE

Excepting for the surplus bagasse, management of the sugar industry is not inclined to part with substitute bagasse for coal, as the dependency on coal availability has been uncertain augmented by transportation problems from pit heads to consumer points as well. If bagasse is to be released for paper making the paper mills must undertake nationally to supply steam to sugar mills in exchange for bagasse, by incurring additional expenditure for installation of coal fired boilers and bagasse handling equipment at sugar mills premises and also undertake to supply coal to these boilers. It is not practical for the paper mills, to operate these boilers exclusively under their management. These additioaal costs, increase the cost of production of paper. In the circumstances, to make bagasse an important and economical raw material for paper making, more incentives have to be offered to the paper industry. Thus the ecology of the country will improve and pressure on forest will be reduced. This can be achieved if the paper mills based on bagasse, have their own sugar mills as ~~a diver~~sion programme by integrating the power and steam units and other service facilities of paper as well as sugar mills, for better performance. In this situation the entire bagsse will be available for paper making.

MNPM ROLE IN UTILISATION OF BAGASSE

MNPM is the only mill working successfully from the past 20 years and of late it is a very happy to note that many sugar mills and many entreprenuer have taken up steps to start paper mills with bagasse as raw matrial. Mandya National Paper Mills have associated with Sri Laxmi Saraswathi Paper Mills, Nizamabad, a 30 TPD bagasse based paper project by, extending their expertise, on advisory consultancy basis. Shri Laxmi Saraswathi Papers have entered into agreement with Nizam Sugar Mill of Hyderabad for procuring bagasse by installing a coal fired boilar at the sugar mill and obtain all the bagasse released in exchange to coal. It is worthwhile to mention here that Mandya National Paper Mills Ltd., with their experience of 20 years are offering consultancy services for bagasse based paper mills. Collabboration with equipment manufacturer is also underway.

Also planning to install a 1250 TCD sugar mill complex for captive generation of bagasse for paper making in their expansion/diversification programme is mooted.

TAMILNADU NEWSPRINT PROJECT

The Tamilndu Government under the leadership of Sheshasayee Pulp & Boards have taken a big step for setting a News Print cum-Writing and Printing paper mill from bagasse. The project cost works out to Rs. 190 crres and proposed to manufacture 50000 annual tonnes of News Print and 40000 annual tonnes of Writing and Printing paper- Six sugar mills in the radius of 100 KM of the proposed factory have agreed to release the required bagasse for the mill. The News Print factory will be installing coal fired boilers in these sugar mills and will be operating the same for supply of steam to the sugar factory in exchange for bagasse,

MPM NEWS PRINT PROJECT

The Mysore Paper Mills Ltd. Bhadravati has expanded its production to 37000 tonnes per annum of writing and printing paper and 75000 tonnes per annum of News Print, then becoming the biggest paper making unit in the country. The pulp furnish for Newsprint is seventy per cent cold soda refined mechanical pulp based on Eucalyptus, 30% chemical pulp based on bamboo. In order to meet the requirement of cellulosic raw material the Mysore Paper Miils are installing a 2500 T.C.D. sugar mill integral with the Paper Mills complex for full use of by-product bagasse for paper making, based on its philosophy of maximum conservation of forest based cellulosic raw material and shifting the emphasis to the extent possible from forest to easily renewable agricultural waste material. They have also planned to augment the sugar mills capacity to 5000 T.C.D.

The areas of intgration will be in the steam generating plants, power generation and distribution, water supply effluent disposal and others so that there will be energy saving in terms of steam and power generation, economy in operation of water distribution and effluent disposal which will be minimised as a result of this integration. It can also be seen that entire quantity of bagasse which is released in the sugar mill will be available for making chemical pulp instead of being burnt for steam production in boiler of the sugar mills

Thus MPM is the first of its kind to achieve the maximum integration for the best of economics.

TECHNOLOGY

Bagasse—Physical and Chemical composition

Bagasse, which forms about 30% of the sugar cane, consists of 50% moisture and 50% fibre along with pith cells The fibre content of this bagasse is around 65% and pith around 30% and solubles around 5% However, when allowance is made for a reasonable amount of dirt and other non-fibrous fines, the typical actual dry composition of bagasse coming from the sugar milling process will be as follows :—

TABLE – 2
DRY COMPOSITION OF BAGASSE[2]

a)	Whater solubles	8-10%
b)	Pith, dirt, epidermis and other fines (nonwater solubles)	35%
c)	Good clean fibre (nonwater Solubles)	55%

The bagasse if purchased on a moisture free water insoluble basis has the following approximate composition as it leaves the sugar milling process :—

TABLE—3
COMPOSITION OF BAGASSE ON MOISTURE FREE WATER INSOLUBLE BASIS[2]

a)	Pith, dirt, epidermis and other fines (non-water solubles)	39%
b)	Good clean fibre (non-water solubles)	61%

TABLE – 4
PROXIMATE ANALYSIS OF BAGASSE & BAMBOO[3]

Particulars	Units	Bagasse	Bamboo
Ash	%	1.8	3.1
1% NaOH solubility	%	30.2	28.3
Alcohol – Benzene solubility	%	1.9	4.2
Pentosans	%	24.1	19.3
Lignin	%	24.2	19.4
Alpha cellulose	%	41.9	46.6
Holocellulose	%	73.2	67.2

The good quality fibre length in bagasse is about 1.0 to 1.5 mm, and its diameter its 19-22 microns. The dimensions of bagasse fibre compared with other raw materials of pulp and paper as follows:—

TABLE—5
COMPARISON OF FIBRE DIMENSIONS

Particulars	Average length (m)	Average Diameter (M)
Temperate coniferous wood	2.7—4.6	32—43
Tropical hardwood	0.7—1.6	20—40
Bamboo	3.0—4.0	14
Bagasse	1.0—1.5	20
Rice Straw	0.7—1.5	9—13

As shown in the tables above, bagasse has comparatively short fibres for paper pulp, resembling tropical wood and rice straw. Being a fibre of open structure it is easy for pulping while higher content of cellulose indicates that it can be used as raw material for paper making.

Drying of Bagasse

Mill wet bagasse as received from sugar mills contain around 50% moisture, with a calorific value of about 3900 BUT/lb, compared to 7650 BUT/lb of bone dry bagasse, A reduction in its moisture content will lead to substantial savings in the consumption of bagasse in sugar mill boilers, thus releasing additional bagasse to paper mills. The sugar industry will stand to gain by way of increased calorific value of bagasse and increased sale of surplus bagasse attendent with other advantages. The calorific value of bagasse, can be estimatd from the following:

TABLE—6
CALORIFIC VALUE OF COMPONENTS OF BAGASSE[4]

Sl. No.	Particulars	Calorific Value (BTU/lb)
1.	Fibre	8280
2.	Sugar	7120
3.	Water	—
4.	Impurities	7330

Water has nc calorific value. The value for sugar and impurities are almost the same and hence the net calorific value of bagasse can be estimatd by the following formula :

Net calorific value=7650—21.6 sugar—87.3 water Btu/lb.

It can be seen from the above formula that the calorific value of bagasse can be improved substantially by reducing its water content. Hence it is desirable to explore the possibilities of drying bagasse to the advantage of both sugar and paper mills. Normally bagasse at sugarmill is baled and stored in open yard. If the bagasse is not baled, not only it is hazardous, but also more expensive in handling for reuse. Using of the waste heat lost through flue gasses to heat the ambient air, in a air to flue gas heat exchangers and use the heated air to dry bagasse, when it is being conveyed, is an important method that can be adopted to dry bagasse to about 35% moisture content.

Transportation

There are several methods of transportation of bagasse.

1 Paper Mills adjacent to the sugar mills can receive their supply of bagasse by : ·

1) a. Belt conveyors.
   b. By pneumatic conveying.

2) a. By bulk road carriers of 16 MT pay load.
   b. Moist depithed bagasse in loose form transported by trucks with a pay load of 15 MT covered by fishing nets.

Normally, bagasse is released by sugar mills at the sugar mill site. Moist depithing of bagasse at sugar mills will improve the release of bagasse fibres. The average load of the road carriers at present is between 7 to 10 tonnes, and that of railway waggons between 3 to 7 tonnes in our case. The advantageous dimension of bagasse bale will be 70 cms. long by 30 cms. width by 30 cms. high and approximately weighs 22 kgs for easy handling and manual stacking. It is preferable to think of large trailors for transporting bagasse, which gives improved economies. Stacks of bagasse are not covered generally. The average stack dimensions would be around 40 M long by 30 M wide by 6 M high to accommodate about 1000 Metric tonnes of bagasse. Sufficient space should be provided in between two stacks (22.87 Metrs. as per insurance stipulations) to avoid fire hazards. The stacks must be provided with clear air space for ventilation. The yard must have adequate fire hydrants. It is observed that the outer surface of the stack may become black, without any appreciable adverse effect on bagasse quality.

STORAGE & PROTECTION :

1. Krausa—Maffei Methcd : Depithed bagasse stored in bulk form without any deterioration.

2. Dr. Cusi process : Baled bagasse is stored as such with well ventilatd stacks provided with sufficient air space. The pith cells present in the whole bagasse protects the cellulose fibre from deterioration, and moisture content also drops down from about 50% to about 30 to 35% in a matter of 40 to 45 days.

After allowing sufficient time, say, 45 days after completion of stacking, the bales are removed for process. Any loose bagasse generated after removal of bales will also be recovered.

3. At one Mill in Mexico, bagasse will be depithed, mixed with water and then pumped onto an asphalted surface platform with a pronounced inclination for drainage of water. Reclamation of bagasse is done by front end loaders.

Ritter biological pre-treatment process :

The general principle of the Ritter process, developed by the E. A Ritter and others, involves the impregnation of the bagasse (moist depithed preferably), with a biological liquor and flushing the suspension to a bulk storage area through elevated channels or by means of a pump-up device. The addition of a small amount of molasses to the initial culture solution provides adequate biological liquor for treatment of incoming bagasse and refortification of the liquor used for flushing the bagasse to storage. The flushing liquor is recycled.

The advantages are preservation of bagasse fibres, elimination of fire hazards, elimination of dust nuisance, lower power consumption, lower chemicals consumption in cooking and bleaching, higher yield of bagasse pulp.

This method though is very ideally suited, involves initial higher investment and continuous import of biological liquor.

Fungus delignification of bagasse

Recent studies conducted by Fungus Research Institute, Kerala. (a subsidiary of Hindustan Paper Corporation), have brought out the selective delignification by fungi, on bamboo and eucalyptus. Further research is taken up to study such fungus attack by selective dissolution of pith and lignin. In fact 2 fungi have been idenified for this selective removal of pith and lignin. Furthrer work on this is in progress. The advantages of such selective pith and lignin removal of bagasse will be, production of quality fibers, lower power consumption in final depithing operation and in refining stages, lower chemical consumption in cooking and bleaching, due to absence of pith. Also load on chemical recovery boiler will be reduced.

Bagasse Preparation

Pith separation from fibre is necessary to upgrade bagasse. Pith constitutes about 30% of bagass, the rest being cellulose fibre (63%) and solubles (5%). The chemical properties of fibre and pith are more or less similar, but they differ vastly in physical and morphological properties. Pith contain lot of soft thin-walled, irregularly shaped parenchyma, cells; has more ash and high absorbing property. Due to its high absorbency, it consumes more alkali during cooking. Because of its soft, thin-walled irregularly shaped fibrous cells, the pith fine swell, make a dense sheet on paper machine wire and with slow drainage. These pith fines would be picked in presses, dryer felts causing press stickiness bringing down machine runnability.

DEPITHING OF BAGASSE

Pith has the same calorific value as that of whole bagasse and its burning in sugar mill boilers (Bagasse fired) does not pose problems other than fly ash. Therefore, it is desirable to separate the pith at least partially, by primary depithing at the sugar mill and return the same fraction for use in the sugar mill boiler with the following advantages :

1. Saving in transportation cost of unwanted pith to paper mills.
2. Partially depithed bagasse forms a compact bale.
3. Disposal of pith at paper mill would be reduced considerably.

METHODS OF DEPITHING BAGASSE :

Methods of depithing bagasse would fall into three categories :

a. Dry depithing method.
b. Moist depithing method.
c. Wet depithing method.

1. Dry depithing method

Hammer shredders, disk mills or the like are used in the separation of pith from bagasse fibre. The loosened pith is screened by either vibratary or rotating screens. The dry pith can be used as fuel in the boiler. The imbibed pith will still remain with the main bagasse fibre. Adequate precaution and protective measures have to be adopted for meeting the dust pollution problems.

2. Moist depithing method

The mill wet bagasse with about 50% moisture is subjected to mechanical abrasion and is carried out at sugar mill. The resultant free pith is used in their boiler as fuel. Thus releasing more bagasse. The resultant fibre then baled and brought to the paper mill. The residual sugar left with the remaining pith will naturally ferment during storage and escape bringing about the necessary heat generation to dry the baled bagasse. Indigenous depithing machinery manufacturing is contemplated by MNPM.

3. Wet depithing method

This method is more applicable at the pulp mill for the final cleaning and depithing just before bagasse enter the digester. In a hydra pulper, the bagasse is thoroughly wetted and broken up and then the pith, dirt and water soluble materials are thrown out in depithing machines. A very clean and uniform bagasse fibre is available for subsequent operations.

A typical analysis of depithed bagasse will be as follows :

TABLE-7

FIBRE AND PITH CONTENT OF BAGASSE

Sl.No.	Particulars		Whole bagasse	Depithed bagasse
1	Fibre	%	62.0	86.2
2	Pith	%	32.0	9.6
3	Solubles	%	6.0	4.2

However, it is observed that about 9–10% of total pith will still be carried forward into the digester.

PULPING PROCESS

Practically all types of pulp can be produced from bagasse. These range from mechanical type of pulp similar to ground wood pulp to high quality bleached pulp of high brightness. Therefore, the process to be used as well as the type and amount of cooking chemicals depend upon the end product required.

Bagasse pulp with or without mixing with long fibred pulp is now used practically in many grades of paper like toilet, tissue, towelling, glassine, corrugating medium, printing and writing papers, and newsprint. Compared to coniferous wood fibres, bagasse fibres are much more bulky, more open, with lower lignin content resulting in quicker penetration of coking liquor. Consequently bagasse fibres require relatively low amounts of pulping chemicals and short cooking time. Continuous pressure pulping for bagasse as well as other agricultural fibres give rapid and well controlled cooking cycles.

Because of low bulk density of bagasse, a relatively high liquid to solid ratio will be needed and provision must be made to agitate the material by rotating the digester or by circulating the liquid or by using built in conveyors or agitators. For production of fully cooked chemical pulp from bagasse, either unbleached or bleachable grades, sulphate, soda and neutral sulphite methods are all applicable and all give good pulps. In case of small pulp mills operating without recovery, the use of caustic soda, as the sole cooking chemical would involve lower chemical cost, than the use of caustic soda with sodium sulphide as in kraft pulping process.

Regarding high yield semi-chemical pulp for corrugating medium the chemicals and cooking process, most commonly used are straight caustic soda and neutral sodium sulphite (buffered with alkali). Both these processes produce high grade bagasse pulp for corrugating medium and the choice between these two processes, depend upon the relative cost of the chemicals. The kraft process will also produce a suitable bagasse pulp for corrugating medium.

High yield bagasse pulp suitable for insulating board or hard board is produced by steaming and subsequent softening rather than chemical pulping. Small amounts of soda ash or caustic soda is added in the digester for pH control, but the principal action is softening so that fibre bundles are made flexible for subsequent mechanical action. Therefore, the pulp required for insulating board more closely resembles the mechanical pulp than the chemical pulp.

The acid sulphite or bisulphite process has been proved by many investigators to be unsuitable for bagasse, because this process tends to give a brittle pulp of low strength properties as compared to bagasse pulp by alkaline process. This process was first tried in Taiwan and subsequently it was abondoned in favour of the neutral sulphite process and then switched over to kraft process.

Methods used for pulping bagasse :

The present pulping methods in use are as under :–

1. Batch pulping process using rotary spherical digesters of tumbling type digesters, under elevated temperature and pressure.
2. The mechano-chemical process using hydropulper at atmospheric pressure as the digesterwith either soda or kraft methods.
3. Rapid continuous pressure digester using horizontal tube digesters with screw feeder and continuous discharge (Pandia continuous pulping) and variation thereof.
4. Crown-Zellerbach Mechanical process for the manufacture of newsprint from ground bagasse pulp and bleached kraft wood pulp.
5. de La Rosa chemical process for the manufacture of newsprint using whole bagasse.

6. Ayotla process using chemical bagasse pulp. bleached with sodium hypochlorite, and mixing it with ground wood pulp for the manufacture of newsprint.
7. The Simon-Cusi process and modified cusi process by mild caustic soda digestion, fractionation and refining to manufacture newsprint.
8. Peadco process using continuous pressurized digestion for pre-hydrolysis of depithed bagasse and cooking with sodium bisulphite and sodium silicate, to manufacture newsprint.
9. Asplund Defibrator Thermo-mechanical pulping to manufacture newsprint.

Following table shows the strength properties of unbleached bagasse pulp (Produced in a laboratory-digester with caustic soda as the cooking chemical) :

TABLE 8
STRENGTH PROPERTIES OF UNBLEACHED & BLEACHED PULP

	Unbleached pulp	Bleached pulp
Initial freeneess °SR	20	2?
Beating time-Min.	30	?0
Final freeness °SR	45	47
Bulk	1.68	1.7
Burst factor	30.3	29.2
Breaking langth	6300	5870
Double folds	29	25

Washing :

The bagasse has a higher degree of hydration as compared to bamboo or wood. Hance the area required for washing should be high. The loading factor for wood pulp is about 0.16 Mt/sft/day and for bagaasse it should be around 0.6 mt/sft/day. A counter current washing system is suitable for efficient washing. The dilution factor will be slightly bigher and the total solids will be about 10% and a free alkali of about 5-6 gpl in washed black liquor obtained.

Screening :

Centrifugal type screens can be used for screening the extraneous materials like sand,dirt, wire pieces etc.

Bleaching :

C-E-H bleaching sequence is suitable to get a brightness of around 80° GE. The total chlorine demand will be about 5-6% with extraction demand of about 1-1.5% alkali on pulp.

Following table represent the strength properties of sheet madeout of bagasse pulp at different freeness and also the fibre classification :

TABLE—9
STRENGTH PROPERTIES[3]

Sl. No.	Particulars	Unbleached Pulp			Bleached pulp		
1.	Beating time. Mts.	15	25	35	15	25	35
2.	Freeness °SR	39	56	77	40	57	76
3.	Bulk	1.9	1.8	1.5	1.9	1.7	1.4
4.	Burst factor	24.6	31.8	33.1	25	32	34.2
5.	Breaking length	3598	4868	5542	3799	4792	5641
6.	Double folds	9	13	18	10	13	18

TABLE—10
FIBRE CLASSIFICATION[3]

Sl. No.	Samples	Retained on -45mesh	-65mesh	+100mesh	-100mesh
1.	Unbleached pulp	40	22.2	14.8	23.0
2.	Bleached Pulp	37.5	21.2	13.6	27.6

STOCK PREPARATION

Bagasse fibre, during the process of pulping and bleaching develops slow drainage characteristics due to high absorption of chemicals and hydration of fibres, therefore requires little refining. However, to bring about fibre uniformity out of heterrogenous fibre bundles of bagasse, the pulp may require mild refining instead of developing hydration. Electrical energy consumption for stock refining is therefore low and the refining HP will be around 3—5HP,day,tonne of installed capacity must be adequate. Treatment of bagasse pulp through finishing jordans, along with the blended refined long fibre pulp, is sufficient to give necessary defibration and dispersion of stock on the machine wire to provide good sheet formation.

It may be better to use disc refiners in place of jordans. Due to slow drainage characteristics of bagasse, it may be required to mix about 10 to 20% of long fibres of either bamboo or wood pulp to obtain proper drainage at the machine. It is better that the long fibre pulp is refined and mixed with the bagasse pulp for greater flexibility of operation, closer control on the degree of refining and for the preparation of stock for various grades of paper. Due to unique fibre characteristics and excellent bonding properties, bagasse pulp requires much less resin-size compared to paper made with conventional fibres. The alum requirement however exceeds the quantity normally used for conventional paper making mainly due to low pH conditions required in the white water system to prevent press stickiness. Use of bagasse pulp to the extent of 50% in the fibre furnish along with long fibre hardly makes any diffe rence in the paper making operations compared to the paper produced with hard wood, bamboo or soft wood fibres. However, as the proportion of bagasse increases and approaches 80% considerable changes in the machine design and operation are necessary to maintain high degree of machine efficiency.

Paper Machine:

When high proportion of bagasse pulp is used in the fibre furnish it is necessary that the Fourdrinier machine should have a longer wire part compared to a conventional design. Also the wire part should be equipped with multiple blade foil system and more number of suction boxes to facilitate better drainage and permit low stock consistency at the head box for improved sheet formation.

Suction pickup or similar arrangement should be provided for web transfer to the press section from the wire part so that the web would not break during the transfer because of low wet strength. The degree of water removal normally achieved with conventional fibres at press section is not applicable to bagasse pulp. The water holding capacity of bagasse pulp is somewhat different compared to other conventional fibres and hence, to achieve better dryness at the press section, it is necessary to try several modern press arrangements. More open type felts are required to maintain enough porocity for better drainage. Adequate felt cleaning devices should be provided to keep the felts and the suction roll perforation clean, to maintain uniform drainage. Due to excessive fines and fibre debris these felts tend to clog up rapidly and therefore arrangements for high pressure showers with automatic controlled movements are critically needed in these areas.

The drying section should be designed to provide more drying surface due to more water carry over with the paper web resulting after the press section. Also smaller dryer groups are preferred to provide better control on drying rates. The evaporation of water in the dryers out of the paper web for bagasse pulp behaves differently compared to conventional fibres because of the stock is more hydrated. It is necessary to have a uniform temperature, over an extended number of dryers compared to conventional fibres. The drying curve is greatly flattened compared to the hyperbolic curve required normally obtained on a conventional fibres. The other features of the paper machine design and operations are similar to conventional paper machine.

Given below is a comparison of strength properties of different grades of paper produced with bagasse pulp at our Mill:

TABLE—11

STRENGTH PROPERTIES OF DIFFERENT GRADES OF PAPER :

Quality	Cr. Wove	Unbl Prtg.	MFKraft	Duplicating (semi—absorbent quality)				
Basis wt. G/M2	58.1	65.9	124.4	68.5	71.5	74.2	63.0	63.4
Caliper Microns	85	95	125	110	115	120	105	105
Bulk	1.46	1.44	1.40	1.61	1.61	1.62	1.67	1.66
Burst pressure Kg/cm²	—	—	—	0.87	0.85	0.90	0.64	0.62
Burst factor	—	—	--	12.70	11.89	11.88	10.16	9.78
Tensile strength in								
Kgs. MD	3.11	3.07	5.04	3.62	3.72	3.73	3.93	2.94
CD	1.75	1.71	3.70	2.34	1.94	2.27	1.79	1.37
Breaking length in								
Mtrs. MD	3569	3106	2691	3523	3468	3352	3206	3091
CD	2007	1811	1980	2277	1809	2039	1894	1441
Double folds MD	4.5	4.0	7.7	5.0	6.0	5.0	5.0	4.0
CD	1.5	2.0	3.2	2.0	2.0	3.0	2.0	1.0
Mean	3.0	3.0	5.5	3.5	4.0	4.0	3.5	2.5
Ash%	9.7	11.2	12.8	13.8	14.2	12.4	14.5	—
One Min. cobb								
Gm m2 min.	21.3	26.9	—	25.6				

SODA RECOVERY

The spent liquor from the washing stages, in case of soda or sulphate pulping of bagasse, contains a very valuable chemical sodium salt & organic matter, which is combustible. Therefore it is normal practice for any paper mill of medium size to instal chemical recovery plant, comprising of :—

1. Evaporator, multiple effect LTV type, to concentrate the spent liquor of weak strength to a desirable concentration, say 50-55%, by means of steam, so that it can be easily pumped to an incenarator or incenarator-boiler.
2. In the incenarator or incenarator-boiler the concentrated liquor dries, the organic part burns with the help of air, thus releasing hot flue gases and the sodium as sodium carbonate. The sodium carbonate flows out of the incenerator as smelt, and after dissolving in water or weak sodium carbonate solution is sent for further processing. The hot flue gasses transfer their heat, through a waste heat boiler, thereby generating valuable process steam. Further catchalls/collectors are introduced to collect the chemical dust going through the flue gases, as the dust is also valuable.
3. The sodium carbonate solution is causticized by lime solution to form sodium hydroxide, which is the main cooking chemical in a soda process. The sludge, calcium carbonate is settled in a series of clarifier, Thickeners and finally filtered out on a rotary drum filter to recover the valuable alkali. The sludge calcium carbonate is either wasted or converted into active calcium oxide either in a fluidized bed calciner or in rotary lime kiln.

For the sulphate process, sodium sulphate is mixed with concentrated spent liquor before it enters the incenarator wherein it is converted into sodium sulphide, under reducing atmosphere.

Our effluent system

A study has been conducted by National Environmental Engineering Research Institute, Nagpur, at our Mills.

Effluent is genrated in the following departments :

1) Bagasse preparation section
2) Digestion section
3) Brown stock washing and screening section
4) Bleaching section.
5) Recovery section and utilities section
6) Paper machine section.

The characteristics of combind effluent will be as follows:

TABLE—12
CHARACTERISTICS OF COMBINED EFFLUENT

Description	Units	Qty.
Flow	Cu.M/Ton paper	401
pH		6.3
Alkalinity	Mg/lit	218
C.O.D.	ppm	1128
B O.D.	ppm	340
Dissolved solids	ppm	716
Suspended solids	ppm	648

The combined effluent is amenable for treatment by standard methods : such as

1. Primary clarification combined with aeration lagoon.
2. Primary clarification with secondary treatment by trickling filter method
3. Primary clarification with secondary treatment by activated sludge recirculation method.
4. Any variation of above.

Treatment for colour removal is rather unwieldy and expensive.

LAYOUT

A typical layout plan for a 50 TPD paper mill is enclosed. The bagasse preparation plant, pulp mill and paper machine can be located in one line whereas utilities, recovery section can be located in adjacent parallel line.

The interdepartmental process plant and machinery can be arranged as per the flow of materials in a sequential manner so as to avoid unwanted handling of raw materials and usege of pipe lines. The storage and handling of raw materials is located to reduce unnecessary handling and transport to their consumption points.

The boiler house, and power plant is located adjacent to the pulping plant and paper machine section to reduce the cost of yard piping, coal storage and crushing will be located near the boilerhouse to facilitate quick and easy handling. Control laboratory and workshop facilities are located well within reach of main plant.

Effluent treatment clarifiers and aeration lagoons be located taking advantage of topography and the points where the treated effluent has to be finally letout. Separate drains from different sections must be envisaged and combined effluent can be taken to the treatment plant preferably by gravity. Treated effluent will flow to its discharge points by gravity. Asphalted roads with flow to its discharge points by gravity. Asphalted roads will be provided within the mill premises and to approach the mill area from the main road.

Adequate area must be provided for future expansion.

Direct causticization of black liquor in digester

Direct causticization of black liquor in the digester by adding lime solution, can be considered for regeneration of caustic soda from sodium carbonate solution, being formed during lignin separation in the digester. Research work is already over and efforts to take up mill trials are being planned.

Auto causticization of black liquor of Ferrite Process

Recent research work at CPPRI, Dehradun, has paved the way of eliminating the causticization of sodiam carbonate to sodium hydroxide, by addition of ferricoxide directly to the concentrated spent liquor after evaporation and fired in a suitable furnace or incenarator. Ferric oxide combine with sodium salt and forms sodium, ferrite, which on hydrolysis releases sodium hydroxide solution and ferrie hydroxide as a precipitate. The precipitated ferric hydroxide car be regenerated as ferric oxide by directly passing hot air over it. This may eventually eliminate the causticiating section and disposal of solid waste calcuim carbonate. Mill trials are being planned in our factory.

Application of RO/UF Technology

Research work conducted at Indian Institute of Technology, Bombay has proved that RO/UF technology can be successfully applied to reduce the effluent load to the treatment plant considerably, by filtering the black plant effluents through a semipermeable membrane under pressure. thereby increasing the recycle of waste water within the system. Research work is now being considered in our Mill to apply the same principle to concentrate the spent liquor, thereby saving the steam used for evaporation process.

Smokeless Briquetted Fuel from Pith

Pith, which is released during depithing has same Heat value as bagasse. Dry pith can be burnt in boilers, however, it is advantageous to convert into briquette form, so that its handling and burning will be easier.

Dried pith, at a moisture content of 25-35% undergoes partial pyrolysis or carbonisation. under controlled condition. During this process, liquid gases and solid char are produced. The gases, being combustible, are recycled & burnt to give the heat of pyrolysis and hence no harmful pollutants would be discharged. The char is then moistend. mixd with suita ble binders like clay and briquetted in a simple machine into any convenient shape or size. These wet briquettes are then dried by external source preferably waste heat from flue gases,

Pilot plant work is under progress.

Financial aspects

Profitability outlook

A profitability outlook has been worked for three alternatives, mainly for the production ot quality printing and writing papers :

01 35 TPD or 10,500 TPA
02 50 TPD or 15,000 TPA
03 100 TPD or 30,000 TPA

The results are enclosed in the following table:

TABLE—13

PROFITABILITY OUTLOOK

Sl. No.	Description	Units	1	2	3
1.	Capacity	TPD	35	50	100
	,,	TPA	10500	15000	30000
2.	Investment	Rs Lakhs	1260	2475	5400
3.	Selling price of paper-average	Rs/T	8759	8759	8759
4.	Less:Variable cost	Rs/t	5193	4650	4444
5.	Contribution	,,	3566	4109	4315
6.	Less: Fixed over-heads incl. interest on short-term loan	,,	1115	941	716.5
7.	Profit	,,	2451	3168	3598.5
8.	AnnualProfit	Rs Lakhs	257.35	475.20	1079 5
9.	Less:Depreciation	,,	72.20	141 82	309.43
10.	Cash Profit	,,	185.15	333.38	770.12
11.	Less: Interest on Long Term Loan-average	,,	66 50	130 16	283 99
12.	P B T	,,	98.75	203.82	486.13

The financial analysis is worked out on the current cost prices of raw materials, chemicals and others.

The operating norms and input requirements for the cost analysis is appended as Annexure I.

Earnings and Profitability

The earnings and profitability are tabulated as follows:—

TABLE—:4
EARNINGS & PROFITABILITY

Sl. No.	Description	Units	35TPD	50TPD	100TPD
01	ROI	%	20.42	19.20	20.00
02	PBT: EQUITY	%	23.66	24.63	25.34
03	BEP (Break-even point)	%	68.3	67.0	62.4
04	Pay back period		8 Years	7-7½ Yrs.	6½-7Yrs.

Benefits :

Besides utilizing bagasse, a waste or surplus material of sugar industry for the manufacture of quality papers, which is in short supply, will lead to potential social and economical benefit to areas surrounding the location of the project.

Conclusions :

Bagasse is a very good raw material for paper, because it needs low chemicals for cooking and bleaching, low steam requirements for cooking & lower power requirements for stock refining. It is also observed that, high percentage of bagasse pulp in the fibre furnish for paper production gives good sheet formation and opacity with comparable printable characteristics for paper. Bleached bagasse pulp can be free of shives and specks and can attain high degree of brightness, without appreciable degradation of strength properties.

Various grades of paper both in medium and light weights can be manufactured using high percentage of bagasse pulp in the pulp furnish. For writing and printing paper, bagasse pulp can be used upto 80% generally.

Considering its potential availabilly, importance must be given to maximize the usage of bagasse for paper manufacture.

Acknowledgement

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ANNEXURE-I

OPERATING NORMS AND UNIT COSTS BY PRODUCTION LEVELS

Production or service units		Units	1	2	3
I	**PAPER**				
01	Daily Production	T	35	50	100
02	**Production pattern**				
	Creamwove 56-60 gsm	%	40	40	40
	Duplicating 70	%	30	30	30
	Ledger Azure 70	%	30	30	30
03	Ash-Average on paper	%	10	10	10
C4	Pulp Requirement Average on paper	%	91.5	91.5	91.5
05	**Pulp furnish**				
	Bagasse pulp	%	80	80	80
	Waste paper pulp	%	20	20	20
06	**Paper chemicals**				
	Alum	%	5	5	5
	Rosin	%	0.8	0.8	0.8
	Soapstone powder	%	10	10	10
07	**Packing materials**				
	Hessian	m	215	215	215
	Gum tape rolls	No	0.5	0.5	0.5
	Jute twine	Kg	0.75	0.75	0.75

(Contd.)

Production or service units		Units	1	2	3
08	**Utilities on paper**				
	Steam	T	12	11	11
	Electricity	KWH	1300	1300	1300
	Water	M.cft.	0.018	0.018	0.018
	Furnace oil	L	130	50	50
2	**INPUTS ON PULP**				
02	**Raw materials-yield**				
	Bagasse-BD	%	36	36	36
	Paper cuttings	%	90	90	90
	Soapstone powder	%	50	50	50
03	**Chemicals-caustic soda for cooking**				
	on Bagasse B.D.	%	13	13	13
	on UB Pulp	%	1.5	1.5	1.5
	Chlorine for bleaching				
	As chlorine	%	3	3	3
	As Chlorine in hypo-chlorite	%	3	3	3
	Burnt lime for causti-dizing and hypo prepn.				
	on Caustic soda	%	130	130	130
	on Chlorine in hypo chlorite	%	150	150	150
3	**FUEL**				
	Coal per tonne of steam generated	T	0.222	0.222	0.222
4	**CHEMICAL RECOVERY**				
01	**Alkali losses**				
	Brown stock washer	%	6.5	6.5	6.5
	Evaporator	%	1.0	1.0	1.0
	Recovery furnace	%	20 0	15.0	6.0
	Causticizers	%	2 0	2.0	2.0
	Miscellaneous	%	0.5	0.5	0.5
	Total losses	%	30.0	25.0	15.0
02	Overall chemical recovery	%	70.0	75.0	85.0
03	Purchased caustic per tonne of paper	%	0.092	0.078	0.051
04	Recovery boiler steam generated per tonne of paper	%	3 0	4.0	4.3

TABLE 2 UNITS COSTS

Production or Service Units		Units	1	2	3
1. Paper Daily production		T	35	50	100
2. Cost of sales-ex-factory incl. CED & Cess–	Cr. wove	Rs./T	8800	8800	8800
	Duplicating	,,	8600	8600	86C0
	Ledger wove	,,	8900	8900	8900
	Average	,,	8770	8770	8770
3. RAW MATERIAL					
Bagasse B.D.		,,	500	500	500
Paper cutting		,,	3684	3684	3684
Soapstone Powder		,,	540	540	540
4. CHEMICALS					
Caustic soda		,,	6265	6265	6265
Liquid chlorine		,,	1825	1825	1825
Burnt lime		,,	590	590	590
Alum		,,	1050	1050	1050
Rosin		,,	11000	11000	11000
Misc. Dyes & chemicals on paper		,,	50	50	50
5. FUEL					
Coal		,,	425	425	425
Furnace Oil		Rs./KL	3030	3030	3030
6. UTILITIES					
Water		Rs./M.C. ft	700	700	700
Power		Rs.KWH	0.4	0.4	0.4
7. Packing cost					
Incl. wrapper on paper		Rs./T	180	180	180
8. Machine wires & Cloth on paper					
Wires		,,	44	42	42
Felts and genl. stores		,,	95	95	95
9. REPAIRS & MAINTENANCE					
Incl. Spares.		,,	288	270	255
10. Selling expenses		,,	130	100	70

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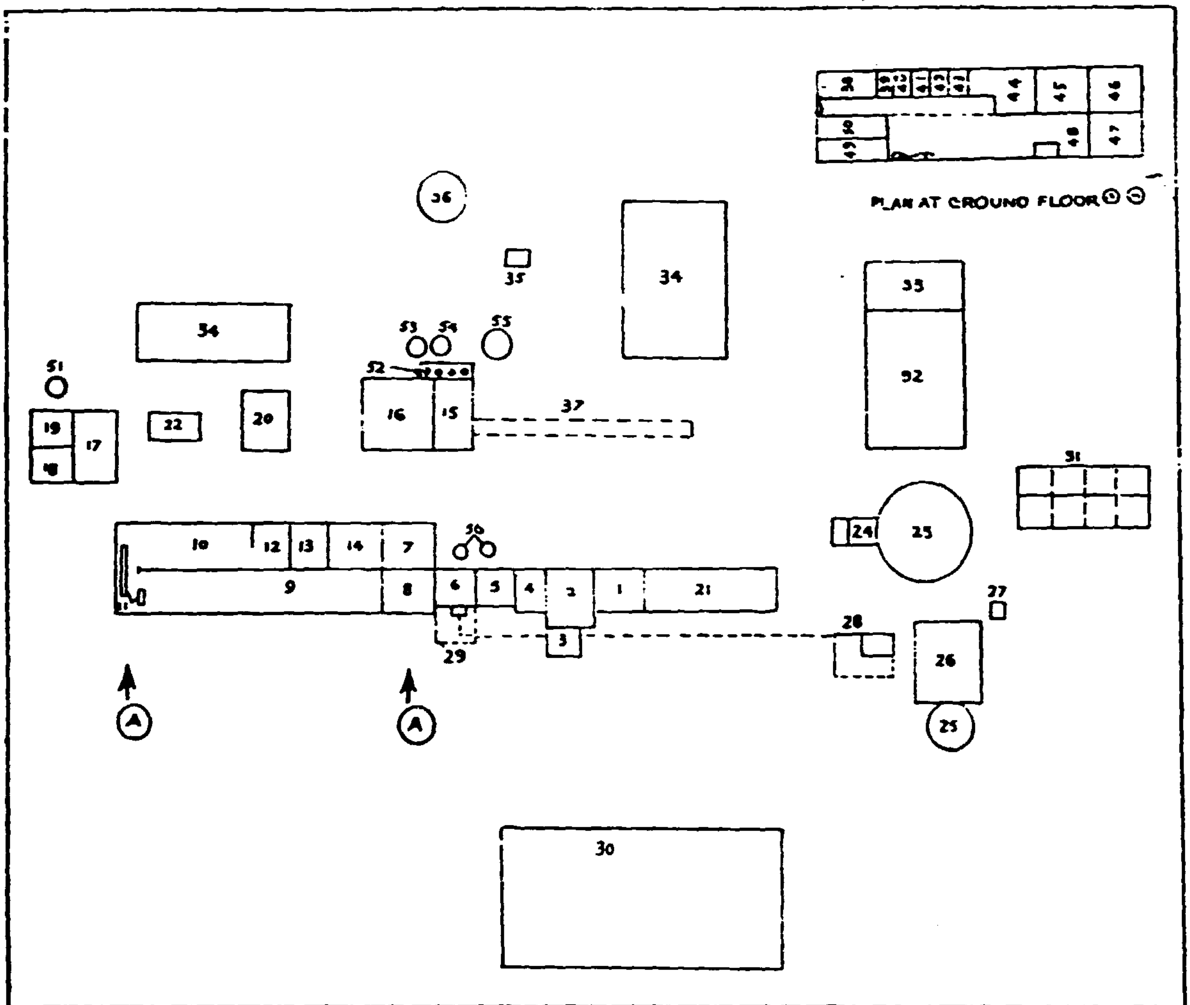

S. No.	DESCRIPTION	S. No.	DESCRIPTION	S. No.	DESCRIPTION	S. No.	DESCRIPTION
1.	Waste Paper Godown	15	Coal Fired Boiler	29	Switch Board Room	43	Core m/c room
2.	Waste Paper Pulping	16	Recovery Boiler	30	Bagasse Storage Area	44	Paper Godowns
3.	Bagasse Treatment	17	Hypo Preparation	31	Sludge Drying Bed	45	Chemical preparation.
4.	Bagasse Digestion	18	Lime Alum Storage	32	Lagoon with Aerat	46	Bleach Plant Chests
5.	Washing	19	Caustizer Plant	33	Polishing Lagoon	47	Machine Chests
6.	Screening	20	Power Boilers & Power Plant	34	Coal Pices 2 nos	48	Compressore
7.	Bleaching	21	General Stores 1	35	Oil Pump House	49	Roll Grinding room
8.	Stock preparation	22	General Stores 2	36	Oil Storage Tank	50	Engineering office
9.	Paper machine	23	Effluent Clarifier	37	Coal Gentry	51.	Shite Liquor Tank
10.	Finishing House	24	Effluent Sump	38	Paper Godown Distributaion	52.	Evaporators
11.	Equpts Rewinder & Cutter	25	Hydro Treator	39	Paper Godown	53.	Thick liq tank
12.	Finishing House	26	Reservoir & Pump House	40	Paper M/c spare parts	54	Black Liq tank
13	Paper Godown	27	300 KVA Transformer	41	Instrument workshop	55	Thin Liq tank
14	Chemical Preparation	28	UKV/440 V Sub station with DP	42	Electrical workshop	56	Unbleached high density

TYPICAL LAYOUT 50 TPD BAGASSE PAPER PLANT same. Whole bagasse has the greatest solubility in hot water and in alcohol-benzene mixture of the three materials.

F. ECONOMICS OF BAGASSE PULPING

The economics of using bagasse for industrial products rather than for fuel at the sugar mill depends to a great extent upon the basic purchase price of the bagasse plus the costs of handling, transportation, and storage. Detailed procedures for making bagasse available for industrial use and the formulas used for pricing the bagasse are included in the literature [14-18]. In many areas with large sugar mills and where substitute fuels may be plentiful and their costs favorable, large quantities of bagasse can be made available for the manufacture of paper, pulp and other industrial products. This amount depends upon:

- An improved or high level of thermal efficiency in the sugar mill whereby a surplus of bagasse is created; and
- The use of other fuels to replace bagasse in the sugar mill boilers.

To provide for the greatest degree of flexibility for operation of the boiler house, it is preferable to install adequate boiler capacity or to modify existing boilers at the sugar mill to operate on alternative fuel as well as on bagasse and pith. This enables the sugar mill to burn any part of the whole bagasse not required for the pulp mill supply, as well as the pith returned to the sugar mill from the moist depithing station. The principles of operation and the equipment available for moist depithing have been described by Atchison [19].

Whether whole bagasse or moist depithed bagasse is supplied by the sugar mill to the pulp mill, the all-important factor in determining its purchase price is the cost of alternative fuel. Even surplus bagasse has a fuel value, as in most cases it can be burned at the sugar mill to produce steam and generate surplus power for the local utility grid, thereby replacing other fuel or conserving hydroelectric power.

The purchase of bagasse for individual uses is, therefore, handled on a contract basis with the individual sugar mills. These contracts provide for the pulp mill to at least pay for the alternate fuel, such as oil, gas, coal, lignite, etc., required by the sugar mill during the grinding season to

Table 18. Proximate chemical composition of commercially baled sugarcane bagasse and woods (oven-dry basis).

Source and Condition	Crops Year	Ash %	Solubility in: Alcohol Benzene %	Hot Water %	1% NaOH %	Lignin %	Pentosans %	Cross & Bevan Cellulose %	Alpha-cellulose %
Lockport, LA, baled, stored 9 mos., sound	1941	2.9	1.7	4.0	32.9	21.3	29.4	58.4	36.8
Stored	1937	1.8	1.7	—	—	26.6	29.1	60.2	43.1
Stored, Sound	1940	6.3	4.0	9.1	36.1	19.6	28.4	55.0	40.6
Houma, LA, dried immediately, baled, represents fresh bagasse	1941	2.4	6.0	8.1	35.9	18.9	30.0	53.3	33.4
Clewiston, FL, freshly dried, dry-screened	1948	2.2	3.5	11.2	39.9	18.1	28.5	52.0	33.7
Temperate coniferous woods	—	1.0	—	—	—	26-30	10-15	—	40-45
Spruce	—	0.5	2.4	3.6	13.9	27.6	10.6	60.0	39.4
Temperate deciduous woods	—	1.0	—	—	—	18-25	20-25	—	38-49
Maple	—	0.5	2.4	2.3	15.9	23.3	22.6	60.2	39.1

Source: "Pulp & Paper Prospects in Latin America", p. 256, United Nations, 1955, and data published by the U.S.D.A. Northern Regional Research Laboratory, Peoria, IL.

replace the whole bagasse or moist depithed bagasse leaving the sugar mill for delivery to the pulp mill. Usually a small premium is paid to the sugar mill in addition to the basic fuel replacement value. This premium might range from US $1 to $2 per moisture-free ton of bagasse purchased, depending upon whether the bagasse is purchased merely on a moisture-free basis or on the basis of "fiber" (moisture-free, water-insoluble solids content as defined by the sugar industry). In some cases, the sugar company may require an additional upcharge for the investment cost of modifying the boilers to burn pith and alternate fuel instead of whole bagasse. Likewise, a rental charge might be made for sugar mill land used for installation of depithing and handling equipment and for bagasse storage.

In actual practice, the purchase contract provides for a specific price for a ton of the [illegible]e "fiber" (moisture-free, water insolu[illegible] plus the agreed-upon premium. In most cases, the bagasse would also have been moist depithed at the sugar mill so that the pulp mill does not have to transport the pith and burn it. Based upon worldwide experience over the many years that bagasse has been used for pulp, paper, and paperboard, and the comparative boiler efficiencies when burning bagasse versus other fuels, it has been rather generally accepted that 1 MT of fuel oil will replace 3 MT (oven-dry) of fresh bagasse, (water insoluble basis) for steam generation.

These calculations are based on fuel oil having a gross or higher calorific value of 10 000 kcal/kg (18 000 BTU/lb). Assuming 80% boiler efficiency for the fuel oil fired boilers, we have an actual

Table 19. Proximate chemical composition of whole bagasse, bagasse fiber, and bagasse pith as related to geographical sources (oven-dry basis).

Source	Variety	Crop Year	Ash %	Lignin %	Pentosans[a] %	Solubility in Hot Water %	Solubility in Alcohol Benzene %	Solubility in 1% NaOH %	Cross & Bevan Cellulose %	Alpha-cellulose[b] %
					Whole Bagasse					
Houma LA	—	1941	2.4	18.9	30.0	8.8	6.0	35.9	53.3	33.4
Clewiston FL	—	1948	2.2	18.1	27.9	11.2	10.8	39.9	52.0	33.7
Hawaii	8560	1952	5.4	21.3	27.7	5.7	3.2	33.9	50.2	31.8
Aguirre PR	Aguirre 1951	1952	3.9	18.1	29.6	8.0	5.4	27.3	50.9	30.1
Negros PI	—	1952	2.3	22.3	31.8	2.8	3.0	31.3	56.8	34.9
					Depithed Fiber					
Houma LA	—	1941	2.2	19.9	32.5	3.4	2.0	30.5	59.0	36.7
Clewiston FL	—	1948	2.0	19.1	30.9	4.5	2.6	31.2	60.4	38.8
Hawaii	8560	1952	2.0	21.1	30.7	2.4	3.6	28.8	56.0	38.3
Aguirre PR	Aguirre 1951	1952	1.2	19.8	31.6	1.4	2.7	27.3	59.9	40.2
Negros PI	—	1952	1.2	21.8	31.2	1.9	2.1	26.8	62.9	41.2
					Bagasse Pith					
Houma LA	—	1941	6.3	18.0	30.7	3.4	2.9	36.2	52.5	30.6
Clewiston FL	—	1948	3.4	18.2	31.4	4.6	2.5	35.0	53.9	32.8
Hawaii	8560	1952	3.3	20.0	33.0	1.5	2.1	30.8	53.5	31.5
Aguirre PR	Aguirre 1951	1952	3.2	18.8	31.9	2.3	2.9	30.3	53.9	32.6
Negros PI	—	1952	2.6	22.5	33.2	3.6	2.7	36.2	55.4	34.9

[a] Pentosans = furfural × factor 0.8

[b] Corrected for pentosans and ash, basis original material.

Source: Pulp & Paper Prospects in Latin America, p. 294-314, United Nations, New York 1955, and U S D A Mimeo Circ. ARS — 71-4, March 1955 heating value of 8000 kcal/kg. Fresh bagasse "fiber" (oven-dry, water insoluble basis, burned at 50% moisture) is assumed to have a higher or gross calorific value of 4600 kcal/kg. The bagasse boiler is assumed to operate at 58% efficiency, which is possible for well-equipped boiler houses, when burning 50% moisture content bagasse. The actual effective heating value will then be:

$$4600 \times 0.58 = 2668 \text{ kcal/kg}$$

The same types of relationships have been developed when natural gas is the alternative fuel used to replace the bagasse. For natural gas with a gross calorific value of 9380 kcal/m³ (1000 BTU/ft³), this calculation shows that a metric ton of bagasse "fiber", when converted into steam in the sugar mill bagasse-burning boiler, would be equivalent to 374 m³ (13 200 ft³) of natural gas. It is interesting to note that a similar relationship, namely that one short ton of bagasse "fiber" burned at 50% moisture content is equivalent in steam production to 12 000 ft³ of natural gas, was accepted for many years in Louisiana starting with the early contracts between Celotex and the sugar companies. For bituminous coal of a gross calorific value of 6665 kcal/kg (12 000 BTU/lb), 1 MT of bagasse "fiber" is equivalent for steam production to approximately 0.5 MT of coal.

Additionally, it should be pointed out that, even if the sugar mill is paid for the whole bagasse as it leaves the cane milling operation on the basis of the equivalent fuel replacement value only, it is more advantageous to the sugar mill to use the alternative fuel. With natural gas or oil, particularly, the boiler operation is improved and labor and maintenance costs are lowered in this area of the sugar mill. Even so, the sugar mill is usually paid the above-mentioned premium equivalent to US $1 to $2 per metric ton of bagasse "fiber".

It is understood that the cost of the moist depithing operations at the sugar mill, as well as the handling and storage of the moist depithed bagasse, is not included in the basic purchase price of the bagasse "fiber". If the sugar mill provides the depithing, handling, and storage facilities, a separate charge is made to cover these costs. In some cases, the pulp mill operates all of these facilities on the sugar mill property and reimburses the sugar mill for any power, labor, or maintenance services which the sugar mill might furnish.

G. DEPITHING

The importance of depithing bagasse before utilizing it for the manufacture of pulp, paper, Joseph Atchison reports on a new method for storing bagasse, developed in Brazil, which could have a big impact on pulp and papermakers, reducing costs and improving quality.

Controlled fermentation is the key

SUGAR AND ALCOHOL producer, Usina Santa Lydia, based in Ribeirao Preto, Sao Paolo, Brazil, is using a unique process for treating, baling and storing bagasse. Called Bagatex-20, it involves the rapid drying of bagasse in 600–900-kg bales, down from 50 to 20% moisture content or less, using a biochemical catalyst which accelerates, but carefully controls, the micro-biological fermentation of residual sugars in the bagasse.

Ever since bagasse became an industrial fibrous raw material in the 1920s, its storage between the sugar cane harvesting seasons has been a major problem. In some cases, storage losses are more than 30% of the bagasse weight. Also, the bagasse quality deteriorates until it becomes unuseable. Because of its high moisture content and bulk, bagasse has either been stored in dense bales or piled in high dense stacks to facilitate storage and handling, and to reduce the storage space required. To preserve the fiber properties, and to reduce storage losses, one of two conditions must exist during the storage period:

- The bagasse moisture content must be below 20% so that micro-organisms which damage the cellulose fiber cannot live or become inactive, or
- The bagasse must be kept wet through and through, or until its water holding capacity is reached, which is at about 80% moisture content.

Efforts have concentrated upon achieving one of these two conditions at economic cost. Developments have tended towards controlling fermentation in the bagasse when it leaves the sugar mill. Usina Santa Lydia started its research in 1980. The aim was to develop bagasse as an industrial fuel, but it appears the research will also benefit pulp and paper companies using this raw material.

Raw bagasse, as it leaves the sugar mill, has a high moisture content (50% and above) and a low density which make it unsuitable as a fuel. It is subject to rapid deterioration and has low-energy production capabilities, so that its safe supply and use are not feasible for industries which operate all year round. Handling, transportation and storage costs are high, and operating efficiency is low, leading to a short economic radius of distribution (up to 30 km).

Bagasse treated by the system can be stored for more than 2 years without fiber deterioration

Bagatex-20 is aimed at eliminating these factors. Bagasse processed by the new system has a far higher fuel value than raw bagasse and can be stored for more than 24 months without fiber deterioration or serious losses. Year-round distribution is possible, at distances up to 180 km.

Applications to the paper industry

Up to the present, all the work on Bagatex-20 has been directed at its use as a fuel. Since pith has practically the same fuel value as fiber, there is no advantage in depithing the bagasse before baling it. However, future development will include moist depithing before the Bagatex-20 treatment process, to attract potential markets in the pulp, paper and board industry.

It is now generally agreed that for good quality, it is essential to remove as much pith as economically feasible before pulping the bagasse. New centrifugal depithing methods have been introduced, using high-speed horizontal or vertical axis hammer mills surrounded by a perforated screen. Regardless of the storage method, it is desirable to remove the pith—which amounts to 30–40% of the weight of the bagasse — at the sugar mill when the bagasse is 50% dry.

This procedure results in appreciable savings in handling, baling, or bulk processing, transport and storage costs. Furthermore, the purchaser does not pay for the pith, but only for the partly depithed fiber removed from the sugar mill. Bagasse bales are more porous after removal of pith and fines, and this

How the new process works

In the Bagatex-20 process, a combination of the catalytic action of a biochemical fluid mixed into the bagasse and the dense bale appears to create favorable conditions for the development of certain micro-organisms already present in the bagasse. This accelerates an exothermic reaction involving fermentation of the residual sugar, gums, waxes, etc.

The biochemical catalyst controls the fermentation so that there is first a gradual temperature increase by the action of the mesophilic microbes which are most active at lower temperatures. As the temperature rises, and the pH decreases, the activity of the thermophilic microbes, which are already present in the bagasse, is stimulated, greatly accelerating the exothermic fermentation reaction. During this period there is competition for food and the mesophilic microbes are killed because the thermophilic ones are more active.

The temperature increases rapidly during the thermophilic stage, with further lowering of the pH. By the time the maximum temperature, and the minimum pH are reached, on about the 10th day, the food is exhausted and most of the thermophilic should further facilitate the release of moisture, heat and acid fumes in the controlled fermentation process.

When selecting the best bagasse storage and handling method for any particular pulping operation, many factors must be considered. However, the trend for several years in bagasse storage has been toward wet bulk storage, with the best method being the Ritter biological pretreatment method which provides controlled fermentation under anaerobic conditions. These methods result in excellent preservation of the bagasse and low losses in storage. Therefore, for most grades of paper and paperboard, except newsprint, where the sugar mill is almost always built adjacent to the pulp mill, it is likely that there would be no advantage of the Bagatex-20 process as compared to wet bulk storage.

On the other hand, there are certain disadvantages to the wet bulk storage system which might be overcome by use of the Bagatex-20 process in specific cases. These are as follows:

- The storage field construction and the equipment involved for wet bulk storage are highly capital intensive and large quantities of water are required.
- The bagasse remains at a low pH of 3.5–4 when using the Ritter process or other methods of wet bulk storage. Thus, all equipment for receiving and handling the bagasse at the pulp mill, including final wet depithing must be made of stainless steel.
- Unless all of the water drained from the wet bulk storage pile is recirculated, the BOD of the waste effluent is excessively high, thus requiring extensive aeration in the waste effuent treatment system.

For a new bagasse-based pulp mill, even where the sugar mill and pulp mill are adjacent, an economic analysis may favor Bagatex-20 over wet bulk storage, especially when water is in short supply, the cost of power for pumping is high, or there are strict regulations on effluents.

In cases where bagasse must be transported to the pulp mill over large distances, Bagatex-20 would have decided advantages over other procedures. Bagasse could be treated, baled, dried and stored at the sugar mill during the harvest, and transported to the pulp mill as required. By allowing the bagasse to dry, transport costs could be considerably reduced compared with hauling it bales at 50% moisture content.

Bagasse processed by the new system can be stored for more than 24 months without fiber deterioration or serious losses. Year-round distribution is possible.

microbes also die. Even those which survive initially, show extremely low activity at low moisture content and eventually die.

During the fermentation, also on about the 10th day, the temperature reaches 60–70°C in the core of the bales and the pH drops from 7 to 2.8 or 3.0, as a result of the acids formed. As the temperature rises, moisture is expelled rapidly from the bagasse through capillarity and is usually already down to 28 or 30% by the 10th day. The high temperature reached remains stable for an additional 10 days or more, and by the 20th day the moisture content has been reduced to 20% or less.

The temperature then begins to decline gradually towards ambient. However, the moisture content also continues to decrease, and is usually down to 15% after 30 days. Along with the reduction in moisture, the volatile reaction products, including acetic acid, also escape from the bales, and the pH gradually rises back towards neutral so that there is no damage to the fiber resulting from the controlled fermentation.

As the drying progresses, the various microbes either die or become completely inactive. Therefore the bales in effect become pasteurized and, if kept under cover, they are preserved almost indefinitely, without deterioration of the fiber.

Mechanical pulp poses special problems

Special problems exist when storing bagasse for mechanical pulp production. In addition to quality losses, problems relating to color and brightness arise. Fresh from the sugar mill, and following moist depithing, it is usually light in color, with a brightness exceeding 40° GE and sometimes as high as 45° if the cane is relatively clean. However, as fermentation proceeds, the bagasse becomes dark and may lose 20 or more degrees in brightness, bringing it down to 20° GE or below.

Since the brightness of the mechanical pulp depends almost entirely on the brightness of the depithed bagasse reaching the refiners, this means that with traditional storage methods, the mechanical pulp will also have low brightness when produced from stored bagasse. The maximum brightness increase which can be achieved using peroxide or hydrosulphite bleaching, or a combination of the two, is about 20°. This means that if the stored bagasse has a brightness of only 20–30° GE, the maximum brightness which can be achieved for the mechanical pulp will be 40–50°, which is not adequate for newsprint.

If, by proper storage methods, the brightness of the bagasse can be maintained between 35 and 40° GE while still maintaining a good open structure, the mechanical pulp can then be bleached to 55 and 60° respectively, at which brightness it is acceptable for newsprint production.

Based on observations of Bagatex-20 bales stored at Usina Santa Lydia, there appears to be little loss of brightness as a result of the catalytic treatment, baling, drying and storage. Bagatex-20 may prove ideal for storing bagasse which is to be used for mechanical or chemi-mechanical pulp for newsprint. The bagasse should first, however, be well depithed, to remove approximately 40% of its weight, using depithers with 8 mm perforations in the screen baskets. This should also result in it being cleaner and brighter going to the baler, and should facilitate the drying process, thus resulting in a superior raw material for mechanical pulp production.

Only a limited amount of chemical testing has been carried out on the Bagatex-20 bagasse before baling and after conditioning and storage, but results from laboratories in Brazil do not reveal any appreciable loss of cellulose, hemicellulose or lignin as a result of the process.

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PILOT PLANT EXPERIENCES BY GIRIS-HZ BAGASSE PULPING PROCESS

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ABSTRACT

A new pulping process for sugar cane bagasse, GIRIS-HZ process based on the CTMP process, has been developed and a pilot plant was constructed at Kanagawa works of Hitachi Zosen Corporation.

From the results of these pilot plant trials, The GIRIS-HZ process promises high yield (80 - 90 %) pulp with remarkable strength properties, low refining energy consumption (1,000 - 1,300 kWh/AD pulp ton), pulp brightness of 50 - 60 % and low chemical charge. Papermaking trails using a test machine show the paper has good printability and the suitability for use as a main component of newsprint grade paper (a mixing rate of 85 % or more).

Furthermore, it is proved that the pulp produced by the GIRIS-HZ process is suitable for corrugating medium by the alternation of chemical pretreatment conditions.

INTRODUCTION

Bagasse, the residue obtained from crushing sugar cane, is well known as one of the most promising raw materials for pulp and paper. Today, a number of bagasse pulp and paper plants employing a chemical pulping process are being operated in various areas of the world.

Since a chemical pulping process is suited for large scale production, it is more advantageous only when an abundant supply of bagasse is available. Use of this process also demands a large investment in plant facilities.
Usually, the excess bagasse output from a cane sugar mill is rather limited. Therefore, there do not appear to be many locations suitable for bagasse pulp and paper plants which use a chemical pulping process either now or in the foreseeable future.
Therefore, pulp and paper plants which allow even the small scale production of paper from bagasse at an economically feasible rate are urgently needed.

In order to meet such needs, Hitachi Zosen Corporation and Government Industrial Research Institute, Shikoku have cooperated to determine an improved new pulping method in hopes of discovering a process.
The process is simplified, requires a smaller investment for the facilities, and is appropriate for even the small scale production.
Joint efforts have resulted in the successful development of a new pulping process, GIRIS-HZ process, that enables the production of high quality pulp suitable for use as a main component for newsprint, writing, printing, wrapping paper and corrugating medium.

The GIRIS-HZ process is based on the CTMP process and a typical flow diagram is shown in Fig. 1.
This process features mild chemical pretreatment prior to pressurized refining and reject refining.
To further develop the GIRIS-HZ process, a pilot plant equipped with industrial production sized equipment was constructed at Kanagawa works of Hitachi Zosen Corporation in spring 1982, and various kinds of pulping trials were conducted during two years.

This pilot plant consists of machinery and equipment such as a depither with a 75 HP motor, a horizontal steaming tube, 24" pressurized and atmospheric double revolving disc refiners with each two 100 HP motors, a KX-100 cowan screen, and a #606-110P centri-cleaner. The flow diagram of this pilot plant is shown in Fig. 2.

This paper will describe the results of the pilot plant trials and typical bagasse pulp qualities and operation conditions.

NEWSPRINT GRADE PAPER PRODUCTION

At the chemical pretreatment, as a mixture of NaOH and Na_2SO_3 brought higher brightness compared with the case of NaOH only from the results of the previous laboratory scale test (1)(2)(3), such combination was used in the pilot plant trials. Generally, for the pulp as a main component for the newsprint grade paper, breaking length is 3 - 3.5 km, tear factor is about 70 and brightness is 50 % or more. Tear factor of the bagasse pulp is rather low, therefore, longfiber chemical pulp is mixed into the bagasse pulp.

Pulp properties

It was found that the kind of bagasse and a degree of the bagasse deterioration affected the pulp qualities. The optimum conditions for the bagasse shown in table 1. were investigated. Before pulping, each bagasse was depithed at approx. 50 % moisture and about 35 % of depither feed materials was rejected as the pith fraction.

The relationship between chemical charge and pulp strength at 120 ml CSF level is shown in Fig. 3. Within a range of 2 - 4 % as Na_2O chemical charge, both tensile strength and tear factor increase linearly with the increase of chemical charge.

The chemical charge needed very slight amount in the case of using fresh bagasse as a raw material to produce quality pulp, but in the case of aged bagasse larger amount of chemicals needed to be added for pulp strength properties. However, the increase of chemical addition causes the drop in pulp brightness and opacity (Fig. 4, Fig. 5). In addition to this result, the pulping yield also decreased (Fig. 6). As shown in Fig. 3, the chemical charge for pretreatment was 3 - 4 % as Na_2O on depithed bagasse up to 3 - 3.5 km.

Typical pulping conditions and pulp qualities for each bagasse to satisfy the requirement for the newsprint grade pulp are shown in Table 2. The fresh bagasses such as sample B and C needed 3.3 - 3.4 % chemical charge to gain about 3 km breaking length, but aged bagasse such as Sample A needed 4 % chemical charge. In both cases, the pulping yield after refining was approximately 80 - 90 %.

Refining energy consumption

Energy reduction in refining is one of the most important problems to be tackled in the field of mechanical pulping process. The energy consumption increased with the drop of freeness level, and its tendency was remarkable at 200 ml CSF below (Fig. 7). The relationship between refining energy consumption and chemical charge at 120 ml CSF level is shown in Fig. 8.

It is seemed that the energy consumption is affected by a degree of deterioration of raw bagasse, the milling condition at the sugar mill and a degree of depithing. However, at the chemical charge of 3 - 4 % as Na_2O, the refining energy consumption was generally about 1000 - 1300 kWh/AD pulp ton and was about half of softwood TMP.

Effect on the two stage chemical pretreatment

The increase of chemical charge causes the increase of pulp strength, but the shive contents tend to increase.
It is assumed that this tendency is caused by the heterogeneous structure of bagasse containing hard tissue and soft tissue.

The improved method of two stage chemical treatment for depithed bagasse and screened rejects has been developed to solve above problems.
Consequently, this method was effected for the reduction of shive contents and the uniformity refining (Table 3).

H_2O_2 Bleaching

In the GIRIS-HZ process, bagasse pulp was bleached by the conventional H_2O_2 bleaching method.
The results of the bleaching trials are shown in Fig. 9.
The brightness gain was nearly 10 - 15 % at 1.5 - 3 % H_2O_2 addition and the brightness of 50 % or more is obtained by one stage H_2O_2 bleaching (Table 2).

Papermaking trials

Papermaking trials were conducted using the fourdrinier paper machine with 450 mm wire width at Institute of Pulp and Paper Industry, Shizuoka Prefecture.
The pulp furnish was bagasse pulp of 85 % and softwood BKP of 15 % and clay of 5 %.
The results indicate that the furnish has sufficient strength to run easily on a commercial basis on a high speed paper machine (Table 4).

CORRUGATING MEDIUM GRADE PAPER PRODUCTION

The GIRIS-HZ bagasse pulping process, which has been developed for the newsprint grade paper production, is also suitable to produce the corrugating medium grade pulp by the alternation of chemical pretreatment conditions.

The process alternated for producing the corrugating medium grade pulp features as follows.

- Chemical pretreatment by NaOH only with the chemical charge of 2.5 - 4 % as Na_2O.
- Steaming conditions at high pressure of 5 - 8 kg/cm^2G and long retention time of 8 - 12 min.
- One (1) stage screening without cleaning system.

The pulp qualities produced by above alternated process flow were higher than those of TMP and nearly equal to those of used corrugated boxes.
The refining energy consumption was about 300 kWh/AD pulp ton.

The typical pulp properties are shown in Table 5.

CONCLUSION

These pilot plant trials were basically carried out with the aim of manufacturing the newsprint grade paper.

The results of these trials by the GIRIS-HZ process were as follows.

- Low chemical charge of 3 - 4 % as Na_2O.
- Breaking length of 3 - 3.5 km
- Refining energy consumption of 1,000 - 1,300 kWh/AD pulp ton.
- Pulping yield after refining of 80 - 90 %.
- Pulp brightness of about 50 % and opacity of about 85 % after peroxide bleaching.
- The newsprint sample made of the furnish of 85 % bleached bagasse C-TMP, 15 % softwood BKP and 5 % ratained clay with the paper machine trial showed the well balanced qualities on strength and opacity.

Consequently, it is concluded that the GIRIS-HZ bagasse pulping process would be suitable to producing a main component pulp for newsprint grade paper (a mixing rate of 85 % or more).

Furthermore, it is proved that the pulp produced by the CIRIS-BZ process is also suitable for corrugating medium by the alternation of chemical pretreatment conditions.

ACKNOWLEDGEMENT

These pilot plant trials have performed in accordance with request from Research Development Corporation of Japan, organized by Government.

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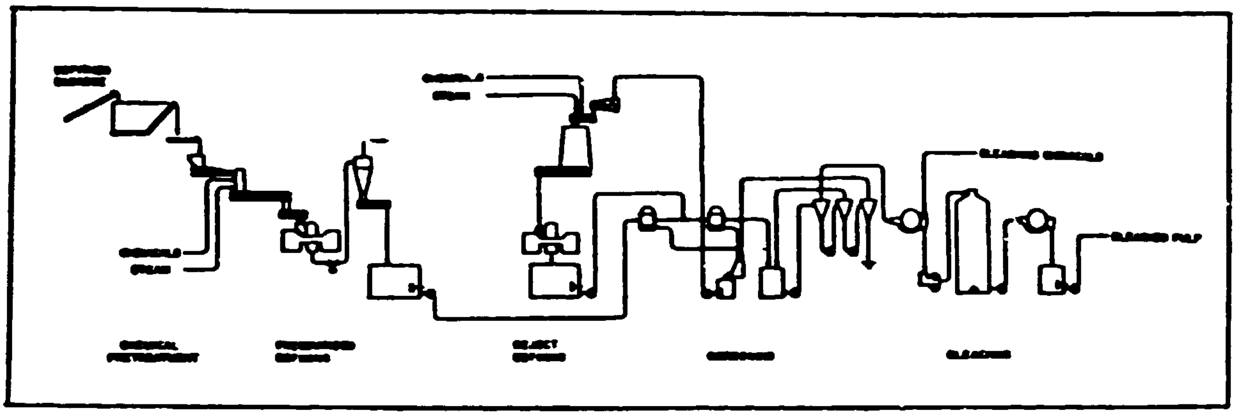

Fig.1   Typical flow diagram of GIRIS-HZ process

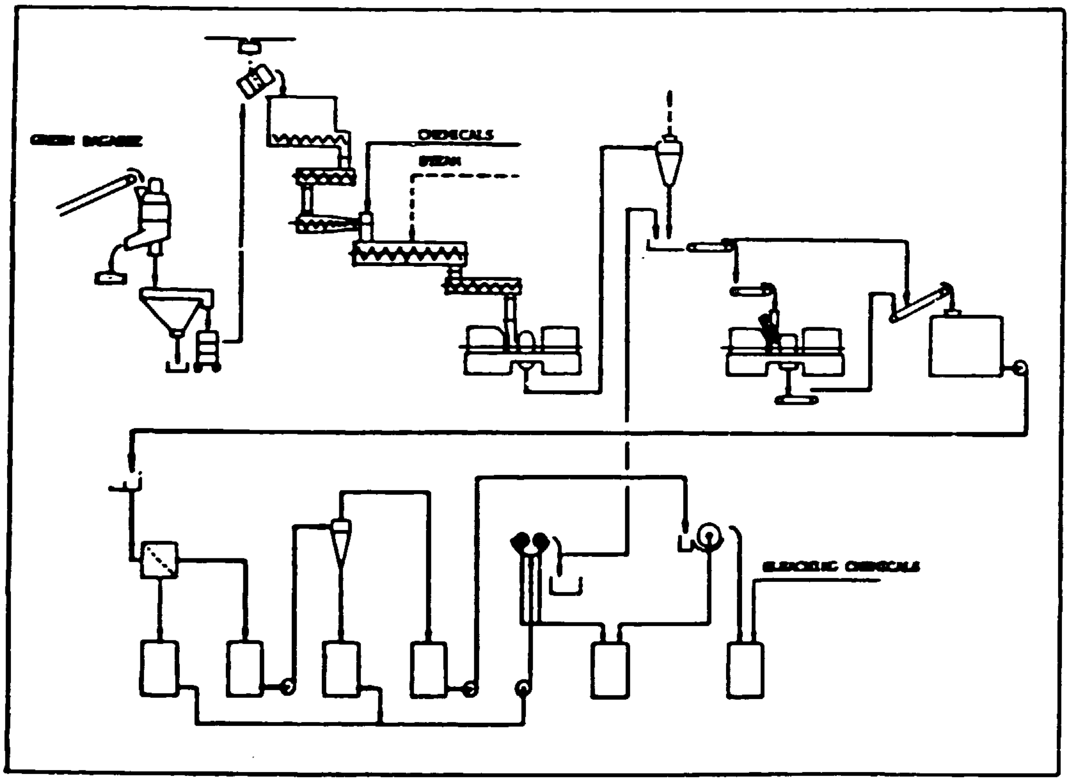

Fig.2   Pilot plant flow diagram

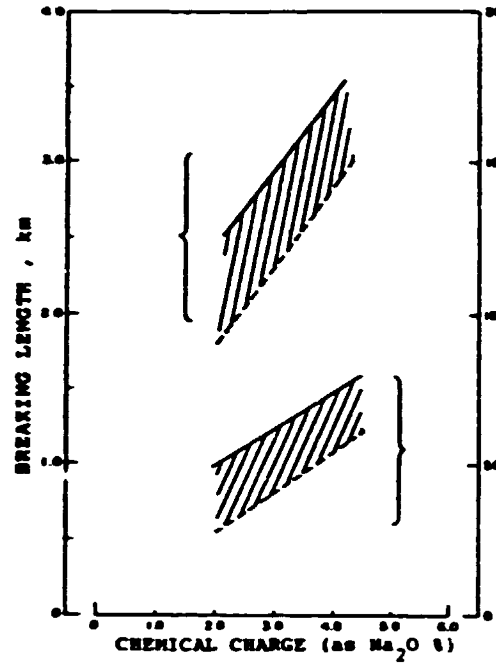

Fig.3 Relationship between chemical charge and pulp strength

Notes, Freeness; 120 ml CSF

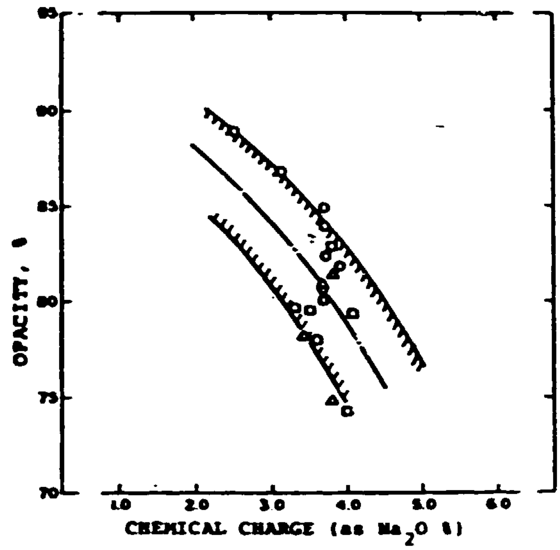

Fig.5 Relationship between opacity and chemical charge

Notes, Basis weight; $50g/m^2$
Brightness; 50 %

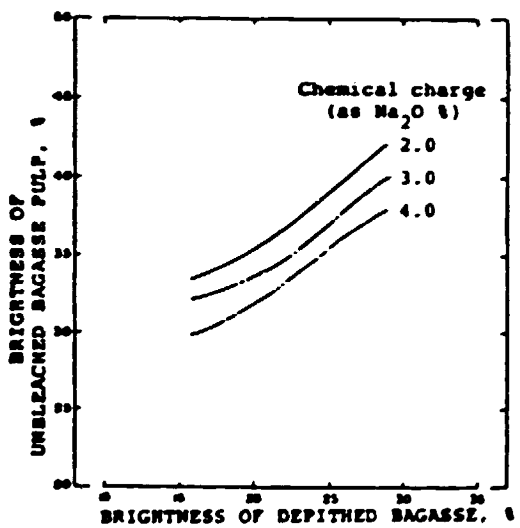

Fig.4 Effect of chemical charge on pulp brightness

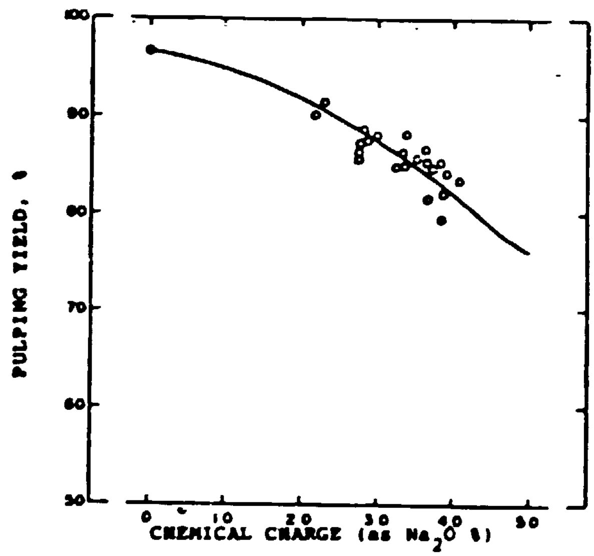

Fig.6 Relationship between pulping yield and chemical charge

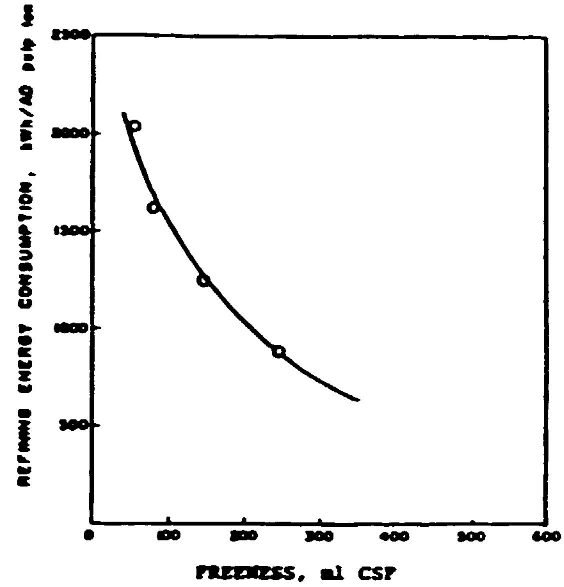

Fig.7 Relationship between refining energy consumption and freeness

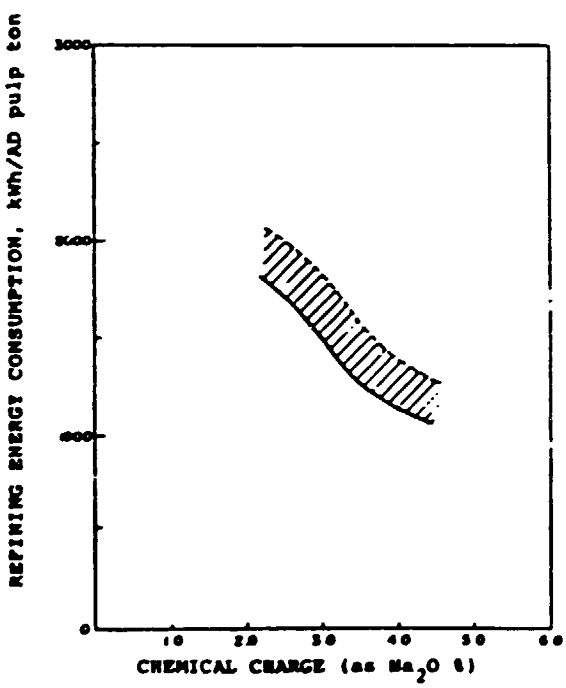

Fig.8 Relationship between refining energy consumption and chemical charge

Notes, Freeness; 120 ml CSF

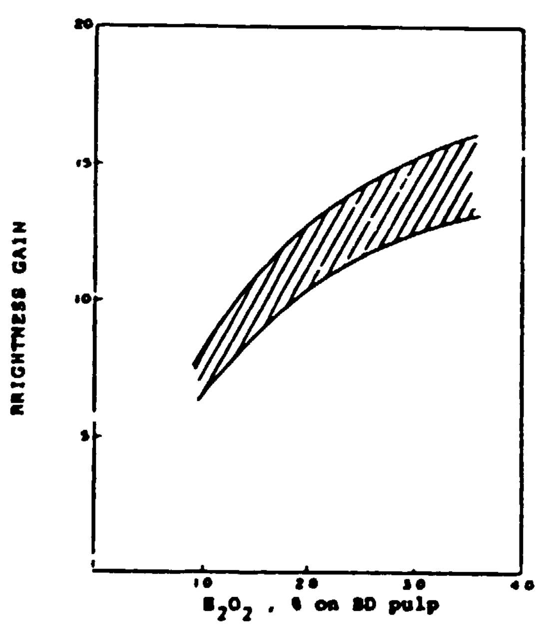

Fig. 9 Effect of H_2O_2 bleaching

Table 1 Raw bagasse conditions

Sample No.	District	Conditions		
		Appearance	Moisture contents	Remarks
A	Indonesia	Bale state	Approx. 15 %	Color; Yellow
B	Japan	Bulk state	Approx. 25 %	No deterioration
C	Pakistan	Bulk state	Approx. 10 %	Slight deterioration Color; light brown
D	Thailand	Bulk state	Approx. 18 %	Slight deterioration
E	India	Bale state	Approx. 15 %	Color; yellow

Table 2 Typical pulping conditions and pulp properties

Raw bagasse No.	B		C		A		D	
Furnish								
Bagasse pulp	100	85	100	85	100	85	100	85
Softwood BKP		15		15		15		15
Chemical charge (as Na_2O %)	3.4		3.3		4.0		3.6	
Pulp properties								
Breaking length (km)	3.2	3.3	2.9	3.1	3.0	3.2	2.9	3.1
Tear factor	58	80	60	82	55	78	70	90
Unbleached pulp brightness (%)	40		34		35		36	
Bleached pulp brightness (%)	51	50	47	46	49	48	50	47
Opacity ($50g/m^2$)(%)	82	88	84	90	80	86	84	91

Remarks; 1) The softwood BKP was blended after beating to a 600mlCSF.
2) The mixed pulp was dyed prior to sheet formation.

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Table 3 Effect on two stage chemical pretreatment

	One (1) stage chemical pretreatment	Two (2) stage chemical pretreatment
Chemical charge on MD bagasse (as Na_2O %)		
Depithed-bagasse	3.6	2.2
Screen reject	0	1.4
Pulp properties		
Freeness, (ml CSF)	105	120
Breaking length, (km)	3.3	3.5
Tear factor	55	55
Shives (Somerville, %)	0.75	0.35

Table 4 Papermaking trials

Raw bagasse No.		A	D
Basis weight, (g/m^2)		53.0	51.2
Density, (g/cm^3)		0.56	0.64
Breaking length, (km)	MD	4.4	4.1
	CD	2.6	2.8
Tear factor.	MD	58	57
	CD	63	62
Brightness, (%)		50.5	46.8
Opacity, (%)		88.5	86.4

Table 5 Typical GIRIS-KZ bagasse pulp for corrugating medium

	Bagasse CTMP	Bagasse TMP	Used Corrugated Boxes
Freeness (ml CSF)	400	400	440
Breaking length (km)	2.8	1.6	3.2
Burst factor	17	9	16
Tear factor	80	43	103
CMT factor	15.5	10.0	11.3
RC factor	15.0	11.0	14.0

Manufacture of corrugating medium paper utilising 100% bagasse furnish

RANGAN S. G.*

SUMMARY

There have been several doubts expressed regarding the possibility of making good corrugating medium paper from a furnish comprising of cent percent bagasse pulp. This paper explores the possibility of manufacture of the above variety of paper using only bagasse pulp and a process working satisfactorily in a mill in Cuba for the manufacture of this variety of paper is described. The author had the opportunity to visit this Cuban mill in 1965, 1968 and 1981.

Paper used for corrugating medium is defined as a paper (but generally classified as paper board) of 0.225 mm (0.009 inches) in thickness-often known as 9 point but sometimes thicker to form the corrugated cushioning layer(s) in corrugated board and single faced corrugated wrapping.

To perform properly fluting medium must be able to accept the stresses and strains imposed on it during its passage into the corrugating laybrinth and be capable of quickly moulding to the flute contour of the corrugator rolls. A major requirement in this respect is ready ability of the fluting to accept heat and moisture. A high moisture content in the web facilitates forming of the flutes and also helps in evenly distributing fibre net work throughout the sheet. Certain pulps have potential capability to produce a more regular, sheet formation and profile, than others.

Common fibrous raw materials used in fluting manufacture in decreasing order of purity are hardwoods, softwoods, bamboo, straw (agricultural residues), bagasse (sugar cane) box shop waste (corrugated board trim etc.) and mixed waste paper. Whether it is made from wood furnish, straw or from secondary fibre the singularly important property of fluting medium is "does it run well on the corrugated board machine ?".

The corrugated medium paper is usually made on a Fourdrinier machine, but not necessarily and from a variety of fibre furnishes. The majority of fluting is made from semi-chemical wood pulp. (But straw, bagasse, reeds and waste paper grades are very common raw materials in a number of countries).

Fluting medium when made from straw pulp is termed "Schrenz" and when made from waste paper is termed "Bogus".

Typical strength properties of corrugating medium paper are given in Annexure 1.

Process suggested for making corrugating medium from 100% bagasse

Fibre preparation

50% moist bagasse is screened in rotary drums or vibrating screens in sugar mills itself to remove as much pith as possible. The separated pith can be mixed with bagasse and burnt in boilers or otherwise disposed off. The partially depithed bagasse can be baled and stored in sugar mills' yard till moisture comes down to at least 35% (to reduce transport cost). If the paper mill is located nearby it can be trasported to (Paper) mills storage yard and stacked.

Depithing at paper mills

Wet depithing using a hydrapulper is the best method of depithing bagasse from the point of view of minimum dust nuisance and fibre damage. Necessary quantity of pith also gets removed without much fibre loss. The bales are fed to the hydrapulper and with addition of water to maintain a consistency of 3% the pith gets loosened almost instantaneously. A retention time of 4-5 minutes should suffice. It will be ideal if the depithed fibre contains 12-15% pith only and pith does not contain more than 10-15% fibre. Any further attempt to depith damages the fibre and results in more fibre loss.

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ANNEXURE—I

Properties of fluting Medium from N S S C. Waste Paper and Straw

Quality	N S S C Fluting			Waste Paper				Straw
Grammage g/m²	108	115	135	163	125	122	170	125
Thickness mm	0.208	0.216	0.263	0.298	0.219	0.233	0.311	0.218
Bulk, Cm³/kg	1.926	1.878	1.948	1.828	1.752	1.910	1.829	1.744
Breaking Length, m: Machine Direction	7,200	7,100	6,800	6,300	2,800	4.900	3.600	3,500
Cross Direction	2,200	2,500	2,500	2,500	1,500	2,400	1,700	2,000
Elongation, %: Machine Direction	1.8	1.4	1.6	1.7	1.6	2.8	1.2	1.7
Cross Direction	2.4	2.6	2.6	2.5	2.5	4.6	3.1	2.2
Burst Mullen, kg/cm²	3.4	3.7	3.9	4.5	1.8	3.4	2.8	2.7
Tear Factor, Thwing-Elemendorf: Machine Direction	56	56	60	56	66	88	82	57
Cross Direction	79	77	77	80	75	95	94	67
Ring Crush Test. lb : Machine Direction	42	51	71	86	30	43	54	38
Cross Direction	30	37	46	60	25	35	39	32
C M T_{30}. lb :	46	50	58	69	27	42	33	34

Digestion cycle

Theoretically, for agricultural residues, only rapid continuous digesters are most suitable in view of the low bulk density-3 kg/cft. However by adopting mechanisation and controlling digestion cycle, capacity of pulping can be maximised even from spherical digesters. Loading should be done by belt conveyors as fast as possible-cooking time should not exceed 90 minutes for corrugating medium in a 12' dia rotary spherical digester.

Filling	40	minutes
Liquor charging	30	,,
Raising to pressure	40	,,
Cooking time	60	,,
Discharging or blowing	30	,,
	200	,,

This cycle is followed in "PAPELERA DAMUGHEE" a paper mill in Cuba located 400 km south of Havana.

Thus from one spherical digester 7 charges should be had and under slack conditions minimum 6 charges should be done. Per charge at least 2 tonnes of pulp at 55% yield is obtained. (5 tonnes of actual weight of bagasse at 20% moisture amounting to a charging of 4 tonnes of B.D. material). 12 tonnes of good pulp for corrugating medium can be obtained from each spherical digester.

Cooking conditions for corrugating medium

Pressure	60 – 80 lb/sq. inch
Total active alkali as NaOH	10 – 12% on B. D. fibre.
(to be decided after trials)	
Strength of cooking Liquor	45 gpl.
(to be adjusted to get a bath ratio of 1:4)	
Cooking time	30 – 60 minutes
Residual alkali in black liquor	3 gpl.

Though neutral sulphite semi chemical pulping is most ideally suited for manufacture of corrugating medium paper, there is no harm in using caustic for cooking (Soda Process).

Washing of pulp

i) The pulp can be washed on a washing drum in a poicher having a breaker and washing drum below the rotary digester

ii) the pulp can be blown to a blow tank

iii) after blow tank, it is important that the fibre bundles are defibrated in a conical or disc refiner or breaker at 4-5% consistency and washed well by passing the pulp through a screw press.

No screening is needed for this type of paper.

Stock Preparation

The freeness of the unbleached pulp can be raised from 25°SR to 32°SR by passing through a brushing refiner before paper machine.

Development of freeness at different points can be as follows:—

After blow pit	22° SR
After disc refining	25° SR
After paper machine brushing refiner	30° SR—32° SR
Head Box	35° SR—40° SR

The physical test properties of corrugating medium paper made in 'PAPELERA DAMUGHEE' Cuba from 100% bagasse furnish are as follows:—

Substance	170 gsm
Thickness (caliper)	12.6 thou.
Bursting strength	65 lbs/sq. inch.
Burst factor	25
Tear factor	98
Breaking length	4280 meters in M.D.
	2760 meters in C.D.
	3520 meters (average)
Tear strength	20 lbs
Tensile strength	24 lbs/15mm width in C. D.

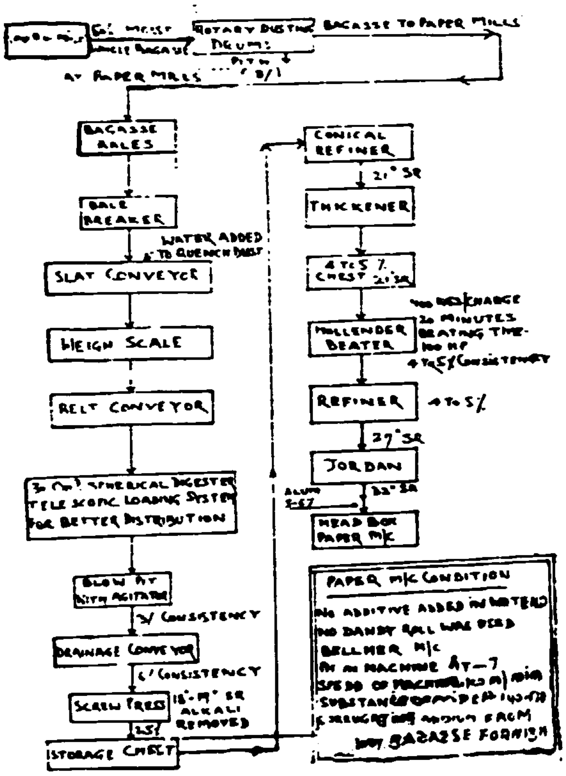
(tested in Seshasayee Paper Mills Laboratory)

Flat crush could not be tested. The Cuban paper tecnnologists say that this quality corrugating medium paper has good export market in their country.

The above process for making corrugating medium is in vogue in "PAPELERA DAMUGHEE" a mill started in 1962 with old machines fabricated and assembled in Cuba itself. This is probably the only mill in the World specialising in corrugating medium paper from 100% bagasse furnish.

A flow chart for bagasse pulping followed in the above mill is enclosed.

FLOW CHART FOR CORRUGATING MEDIUM IN PAPELERA DAMUGHEE CUBA



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EXPERIENCES OF BAGASSE PULPING WITH RAPID CONTINUOUS DIGESTER.

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ABSTRACT

Bagasse is a valuable raw material for pulp and paper manufacture if pith is removed effectively. The depithed bagasse contains 55% useful cellulose. Pulping depithed bagasse in a rapid continuous digester gives pulp of acceptable quality with good strength properties in a shorter time cycle. The experience of Seshasayee Paper & Boards,(SPB), India, in pulping of bagasse in rapid continuous digester is described in detail.

INTRODUCTION

In a tropical country like India, the availability of long fibred soft woods are scarce, as the forest area having conifers account only for about 5% of total forest area and that too is situated in inaccessible regions and is economically unexploitable.

In 1959, when the proposal to set up a paper mill was first mooted by SPB, an intensive survey was carried out in Tamil Nadu to estimate the sustained annual yield of bamboo. The survey disclosed that the availability of bamboo after meeting domestic demands would hardly be adequate to sustain a mill rated to produce 60 tonnes paper daily and that therefore the mill to be set up should be designed to process not only bamboo but also other substitutes known to yield pulp of acceptable characteristics. Hence, recourse to sugarcane bagasse as a partial substitute for bamboo became inevitable.

CHARACTERISTICS OF BAGASSE

Bagasse is diverse in composition from other pulping materials in that it consists of two heterogeneous fractions - fiber and pith. Pith is characterised by its dust form and is composed of paranchyma cells. Because of its small dimensions, non-fibrous physical nature and close association with dirt, pith cannot be converted into a satisfactory pulp inspite of its resemblance to the fibre in chemical composition. Approximately, pith content in B.D bagasse is between 30-35% and moisture content is between 40-50% as it comes from sugar mill after the extraction of juice. The cellulose content in bagasse is comparable with other conventional raw materials. If pith is removed, the useful cellulose content in bagasse will be about 55%. The lignin content in bagasse is around 19-20% lower than that of hard woods. The pentosan content in bagasse is higher than that of hard woods, but after depithing, much of the hemicellulose is removed and the pentosan content is reduced to 20-25% which is very close to that of hard woods. Ash content in bagasse is one of the lowest in grass fibres. The depithed bagasse contains 1 - 1.5% ash. The fibre length of bagasse is around 1.7 mm. Thus bagasse proves to be a suitable fibrous raw material for pulping (1).

A bamboo/bagasse based integrated pulp and paper mill of 20,000 t/annum capacity was planned by SPB. Trials conducted revealed that bamboo is an ideal fibre blend for bagasse pulp in any desired proportion depending upon the grade of paper to be manufactured as bamboo is a long fibred raw material.

CHOICE OF RAPID CONTINUOUS DIGESTION

Conventional type of digesters used for wood or bamboo are not suitable for bagasse as liquor circulation is not satisfactory in the latter part of cooking. Cooking liquor is readily absorbed by bagasse and considerably higher liquor to fibre ratio would be required to have a reasonably good circulation.

Over the years the trend towards greater utilisation of bagasse has gained tremendous impetus. Parallel to these fast moving developments, there has been amazing development towards continuous pulping, with special emphasis on rapid continuous pulping. By rapid pulping is meant, total cooking cycles of 5 - 25 minutes, which are almost unbelievable in the past, when traditional cooking by batch process required a total cycle of 2 - 12 hours (2). This is due to the discovery that the long cooking times traditionally used for agricultural fibres and in particular to bagasse were completely unnecessary. In fact these long cooking times have been found to be detrimental to the quality of the pulp. Further, shorter cooking times have resulted in lower chemical and steam costs. Because of the bulky nature of these agricultural residues, capacities of the traditional batch digesters have been low and high liquor to solid ratios for uniform pulping posed problems in spent liquor recovery.

Despite certain disadvantages with the rapid continuous digestion system, it has become popular because of greater advantages like the flexibility of allowing production of different types of pulp with short changeover time, shorter cooking time, lower chemical and steam costs.

SPB is the first mill in the world to set up a rapid continuous digester in 1961-62 for chemical pulp from bamboo as well as from bagasse in the same equipment.

After a detailed study of all alternatives open, it was decided to incorporate the following essential features for setting up the plant.

a) To raise steam for sugar mill in oil fired boilers in replacement of steam produced by use of bagasse as fuel.

b) Primary depithing in Horkels at the sugar mill and baling thereafter the depithed bagasse. The pith removed is to be sent back for reburning in bagasse fired boilers.

c) Transport of partially depithed bagasse and storage at paper mill instead of at sugar mill.

d) Secondary depithing in Horkels after the bagasse has dried by exposure and burning resultant pith in admixture with bamboo dust in paper mill boilers.

e) Processing of bamboo and bagasse in one stream in regular sequence. This was decided upon as processing in two independent streams would have called for duplication of equipment and entailed a very heavy capital outlay. The natural corollary of this decision was the installation of a continuous digester for preparation of pulp both from bamboo and bagasse.

Table 1 gives the proximate analysis of bagasse available from the nearby sugar mill.

Sl No	Particulars	Whole bagasse %	Depithed bagasse %
1	Moisture	52.0	-
2	Ash	2.1	-
3	Solubility in hot water	18.1	-
4	Solubility in 1% Na OH	26.0	-
5	Solubility in Alcohol Benzene	1.1	-
6	Pentosans	23.9	-
7	Lignin	18.8	-
8	C and B Cellulose	55.2	-
9	Pith and fines	32.6	19.0
10	Fibre/pith ratio	100:61.2	100:27.6

Table 1 : Proximate analysis of bagasse

DEPITHING AT SUGAR MILLS

It was planned to remove maximum amount of pith before pulping to obtain good quality pulp from bagasse. In order to accomplish this in the most economical manner, a large depithing installation was needed at the sugar mill.

Before the bagasse could be diverted to pulp production from its former use as fuel in the sugar mill, two modern oil-fired boilers were installed to raise the required steam. Two of the old bagasse-fired boilers were kept in readiness to burn the pith in emergencies.

No difficulty was encountered in burning the pith. The combustion was quite satisfactory in the old bagasse boilers as long as enough air was supplied from underneath so that the pith would burn in suspension. The efficiency obtained was quite satisfactory and compared favourably with that obtained burning whole bagasse.

The total quantity of bagasse coming from the sugar mill tandems was passed through two "Horkel" depithing machines. The machine and process developed at Louisiana State University by Paul M. Horton and Keller appeared to answer the requirements for a successful depithing operation. The machine is a modified swing-hammer mill which could be operated either "dry" or "wet". The bagasse from the sugar mill can be fed into one end of the machine and travel across the tips of the rotor hammers during which time it gets subjected to a beating and combing action. The pith and dirt loosened by that action falls or is dragged around the hammer circle and forced out through a perforated plate which closes the lower half of the rotor circle. The depithed fibre passes out of the end of the machine to another similar unit for "Wet" processing or to storage.

The separated pith went directly to the converted boilers, and the separated fibre was conveyed to baling machines. The pith was burned in the boilers with a moisture of nearly 50 per cent.

ADVANTAGES IN DEPITHING THE WHOLE BAGASSE AT SUGAR MILLS

(i) By removing a high proportion of the pith at the sugar mill, the sugar factory can burn pith as fuel. The cost of replacement fuel was reduced accordingly and the pulp mill was not charged with the undesirable pith which it cannot use.

(ii) Baling costs per ton of useable fibre were reduced by the absence of the pith and dirt.

(iii) Handling costs drop, because more fibre was handled per man-hour when the bales were formed of depithed bagasse.

(iv) Freight charges go down if each ton of bagasse transported was more pure fibre and less pith and dirt.

(v) A pulp mill digester charged with a ton of depithed bagasse will yield approximately 20 per cent more paper-making pulp than one charged with undepithed bagasse. Most of the pith in the whole bagasse merely dissolves out in the digester or forms undesirable products which must be removed later in the process.

Comparative tests have shown that substantial savings were possible through depithing at the sugar mill. The cost of baling was much lower in 1963-69 as compared to the cost of transportation. Hence depithed bagasse was baled and transported.

BAGASSE STORAGE

Since the normal grinding season in the sugar mill was 150-250 days, it became necessary to store large quantities of bagasse to provide for the operation of the pulp mill the whole year round. This required considerable space.

The losses in the stored bagasse usually run between 5 and 10%, depending mainly on the local climate. Whether or not the storage piles should be covered was an economical decision to be made. In recent years, the idea of bulk storage has received a considerable amount of attention and many companies have investigated the possibilities of its use. SPB stored the baled bagasse in uncovered stacks. The whole storage area was carefully graded so as to provide natural drainage during heavy rains and equipped with an up-to date fire fighting system.

The only additional requirement from the fire insurance company was to keep the piles at a maximum size of 1000 tonnes of even dry bagasse per pile, and to keep the space between piles at no less than 75 ft end to end and 120 ft side to side (3)

PULP MILL OPERATION

BAGASSE FIBRE PREPARATION IN THE PULP MILL:

Normally, bagasse was received at the pulp mill in bales during the storage season and, in order to obtain a good clean pulp, a secondary depithing was necessary.

Secondary depithing by the "wet" method was now considered essential in order to obtain a clean fibre, higher yield and low chemical consumption. In some mills, due to special local conditions, a secondary wet system is not practical. In that case, a secondary "dry" depithing was recommended. Secondary dry depithing is by no means equivalent to the wet depithing and does not provide the same "cleanliness" in the fibre. Nevertheless, it is recommended in all cases where wet depithing was not possible.

At SPB, two Horkel dry depithing equipment were installed for secondary depithing.

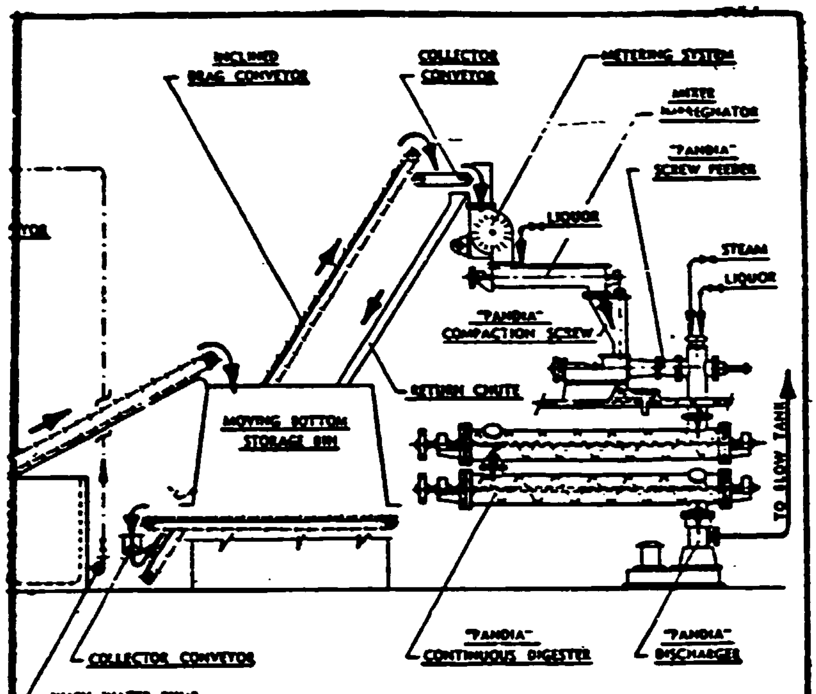
PULPING

After a comprehensive study of all digestion systems available, a Pandia continuous digester was selected for pulping the bagasse. The decision was based on satisfying the needs of pulp quality, control of cooking conditions, minimum building space, and low investment cost. The pulp obtained from this system was of a very uniform quality; yield was high, and steam requirements were low. The consumption of raw material, steam and power, and liquor was uniform. The two-tube digester was designed for a capacity of 60 tons per day.

It was found that the fast cook provided by this equipment was quite satisfactory and gave a pulp of acceptable quality.

COOKING OF BAGASSE IN RAPID CONTINUOUS DIGESTER

The cleaned bagasse is transported by an inclined slat conveyor to the Pandia continuous digester. Ahead of the Pandia digester there is a paddle mixer which receives the bagasse and acts as a shredder. From the paddle mixer the bagasse is fed through a vertical chute to the screw feeder mechanism of the Pandia unit. The screw feeder helps in further squeezing of



Pulping bagasse in Pandia continuous digester.

water from bagasse. Considerable quantity of water solubles as well as pith are removed along with the squeezed out water through the perforated throat of the screw feeder. During the process of squeezing out, the bagasse attains a dryness of about 40% and forms a plug to prevent escape of steam from the cooking zone. Besides the plug formed by bagasse, a blow back valve has been provided to closely control the escape of steam from the digestion zone (4).

The operation of transporting conveyors, screw feeder, blow back valve, both the Pandia tubes and the discharger which is electrically interlocked is controlled from a central panel so that if there is any interruption in any unit operation, the entire system trips off. The Pandia digester at SPB consists of two horizontal tubes each having a length of 39' 10" and dia of 42" with time control screw, having notched flies driven by variable speed drives. Two 16" dia screw feeders, one for bagasse and another for bamboo/wood with plug pipe, throat inlet chamber and tee piece are provided. This continuous digester has two tubes fitted with 30 flight 14" pitch time screws. The screw feeders are 16" at start and ends at 12½" with a length of 54". 18" dia discharger with a 1 - 1/3" orifice valve is provided. A blow back valve with a 3' stroke piston works as a safety valve. The horizontal Pandia tubes are located one over the other operating in series. Cooking liquor is injected in the high pressure zone at the entry of the digester along with steam. The screw conveyor in the first tube is usually of the mixing type to ensure uniform heat transfer, for uniform pulping. The cooking of bagasse proceeds as the bagasse is carried from the first tube to the second tube. Both the tubes are equipped with variable speed drives so that the retention of bagasse in the cooking zone can be adjusted suitably depending on the quality of pulp required.

Cooking of bagasse is carried out at a pressure of 80-100 psi using 12 - 14% Na OH (Soda Pulping) and with cooking time of 10-12 minutes. Fibre to liquor ratio inside the tube is maintained between 1:3.5 to 1:3. Concentration of cooking liquor is kept at 4-6%. The pulp produced under these conditions is soft and easily bleachable. The permanganate No of pulp is 9-11 having an initial slowness of about 23-25°SR. The unbleached yield of pulp on depithed bagasse is 42-44%.

The free residual alkali is maintained around 8-10 gpl Na OH per litre in the spent liquor which is found to be optimum for satisfactory washing of the pulp and subsequent recovery operations. If free residual alkali falls below this level, the filterability of brown stock is adversely affected. High free residual alkali prevents precipitation of lignin and lowers the viscosity of the thick black liquor. Compared to bamboo black liquor, bagasse black liquor is more viscous. However this does not cause any serious problem as the Weak Black Liquor from bagasse pulping is mixed properly with Weak Black liquor obtained from bamboo pulping.

The cooking conditions (time and per cent caustic) vary considerably depending on the type of pulp being produced. The permanganate number was as low as nine, when making high quality bleached pulp from bagasse.

For the operation of the complete Pandia system including control of the feeding conveyors, pre-impregnation, control panel, sampling, liquor preparation, and control of auxiliary equipment, only one skilled operator and two helpers were needed per shift.

WASHING, SCREENING AND BLEACHING

Washing is done in a 8' dia 10' face size 3 stage brown stock washers with shredders and repulpers. The screening of the washed pulp is done in Trimbey screens and Vorject centricleaners. Bleaching plant consists of 4 filters of 8' dia, 10' face with CEHH sequence, with heater mixers and retention towers. Bleaching of bagasse pulp is carried out separately and then only blended in stock preparati plant along with bamboo/wood pulp. Bagasse pulp can be easily bleached to a brightness level of 75-78% with 6-8% chlorine. The bleached pulp has a freeness of 400-450CSF. The bleaching loss is around 8 per cent.

CHARACTERISTICS OF BAGASSE PULP

Properties of unbleached and bleach pulp made with rapid continuous digester evaluated in lampen mill for 15,000 revolutions are given in Table 2. Physical strength properties are good excep tearing strength which is low.

Bagasse pulp cooked in rapid continuous digester can be mixed with bamboo/wood pulp in any desired proportion and almost all grades of paper are produced. When bagasse pulp is mixed with bleached bamboo pulp, it has been proved beyond doubt that varnishability, surface oil absorption and wax pick improve with the increase in percentage of bagasse fibres in the furnish (5).

Almost all varieties of paper like writing and printing, posters, tissues, napkin, wrapper and coated paper can be manufactured using various furnish mix and certain grades of paper can be made from 100% bagass pulp (6). Properties of different varieties of paper made with different proportions of bleached bagasse pulp are given in Table 3.

No	Unbleached bagasse pulp °SR Initial	°SR Final	BF	TF	BL	DF	Bleached bagasse pulp °SR Initial	°SR Final	BF	TF	BL	DF
1	33.0	45.0	43.3	48.3	5757	195	31.0	39.0	33.6	35.4	6012	72
2	35.2	45.4	45.6	48.3	6583	225	34.0	45.5	40.8	42.9	6115	50
3	29.0	42.0	46.1	49.1	6114	282	35.0	48.2	35.4	33.9	5787	47

BF : Burst Factor TF: Tear Factor BL: Breaking length DF: Double Folds

Table 2 : Laboratory evaluation of Unbleached and Bleached bagasse pulp.

Quality	Substance g/m²	Burst Factor	Tear Factor	Breaking Length (Avg) m	Double Folds	Remarks
Creamwove	60	16	42	3000	8	70% bagasse : 30% imported Sulphite pulp
Duplicating	75	14	57	3150	7	80% bagasse : 20% imported Sulphite pulp
Duplicating	75	17	48	3100	9	100% bagasse pulp
Manifold	33	22	57	4000	7	70% bagasse : 30% imported Sulphite pulp
White Printing	60	18	60	3707	10	90% bagasse : 10% imported Sulphite pulp
White Printing	60	17	50	3061	8	100% bagasse pulp
White Printing	67	17	50	3400	8	100% bagasse pulp
White Printing	43	11	46.5	5332	5	-
Badhami Paper	55	9.8	43.6	2672	16	-

Table 3 : Physical properties of different varieties of paper manufactured with different proportions of bleached bagasse pulp.

PROBLEMS ENCOUNTERED IN THE OPERATION

a) The bagasse bales were breaking up during handling and a substantial percentage had to be handled loose. This proved to be a very arduous, expensive and wasteful process. This problem was got over by rebaling the loose bagasse before feeding into Horkels for secondary depithing.

b) The chain slat conveyors often broke down resulting in stoppage of pulping of bagasse for hours together. During this time, bamboo pulping had to be done for meeting the pulp demand from paper machines.

c) Dry depithing created a very dusty atmosphere and the fine dust was health and fire hazard. Fine misty water sprays were introduced on bagasse conveyors to minimise this problem.

d) The low density of bagasse 40 kgs/m³ set an upper limit to the input into Pandia and consequently to the output of pulp. The best out-turn obtained was 2.5 tonnes of pulp per hour as against 3.75 tonnes with bamboo and hard woods.

e) While the run of the Pandia was smooth and continuous, when bamboo was processed, it was frequently interrupted during bagasse processing, primarily because any small foreign material in the bagasse choked up the discharger valve. A variety of screens and magnets were installed in the process stream, but even so the mill has not succeeded in eliminating passage into the Pandia of foreign materials like baling wire, stones, nuts and bolts and the like.

f) The yield of unbleached pulp from depithed bagasse was of the order of 42% corresponding to 33% on the whole bagasse, as against 45% from bamboo and hard woods.

g) The loss of alkali during washing of bagasse pulp was of the order of 35-40 kg expressed as Na_2SO_4 per tonne of pulp as against 15 to 20 kg in the case of bamboo. To obtain an acceptable washed bagasse pulp, the washers have to be run slower - the rate of washing being 2.5 t per hour as against 3.75 tonnes in the case of bamboo. Also the dilution factor has to be much higher out of necessity. The strength of Black Liquor from bagasse pulp passed on to recovery was of 8° TW at 70°C, as against a normal 14°TW with bamboo liquor. As a result of excessive percentage of fines in the bagasse pulp, the washing was difficult and slow.

h) Since only one set of bleaching equipment was available and it was not possible to empty the towers at every changeover, bagasse and bamboo bleached pulps were inevitably getting mixed up rendering regular proportioning at the paper machine difficult to achieve. To overcome this, and as part of the expansion scheme, provision was made install a new set of bleachers to deal exclusively with pulp from bagasse.

i) When bleached pulp stock was low, proportioning of bamboo and bagasse pulp was impossible. Either hundred percent bamboo pulp or hundred percent bagasse pulp found its way to paper machines.

The agreement made by SPB with the nearby sugar mill had to be terminated by mutual consent in 1969 as the furnace oil cost increased six fold, and hence the cost of bagasse released by sugar mill became high and uneconomic. Hence, SPB decided to use hard woods instead of bagasse for meeting pulp requirements.

However after 1969 till date, as and when surplus bagasse was made available, at economic price, bagasse is processed and pulped in rapid continuous digester after single stage depithing.

CONCLUSION

Bagasse is a suitable raw material for paper making. SPB started their 60 t/day writing and printing paper mill in 1962 using bagasse as primary raw material. The mill's experience had shown that by using a rapid continuous digester, bagasse pulp could be produced. The pulp could be bleached and good grades of writing and printing paper could be made. The mill's experience has also shown that with the present cost of furnace oil, it is not economical to take bagasse for paper making from the sugar factory in exchange of furnace oil.

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Production of Bagasse Based Papers On High Speed Machine and Quality Assurance

MEHROTRA A.K.*, SARKAR P K.**

Preamble

With dwindling supplies of conventional forest based raw materials, the only dependable raw material available for paper making in India for large sized news paper mills is bagasse.

Bagasse being short fiber and relatively weak furnish, it is found difficult to run bagasse furnish on conventional fourdrinier machines even at moderate speeds to produce bagasse based papers viz cultural and newsprint grades at high machine speeds and efficiency, selection of stock preparation equipment and paper machine is very important and the same is discussed below.

Stock Preparation

Bagasse pulp being slow draining pulp, does not require additional refining in stock preparation except for control refining of mixed furnish viz bagasse hardwood and broke etc. DD refiners with automatic programmable controls are desirable for control refining. Watt sensitive controller provides automatic adjustment of disc spacing for startup and to hold preset power during normal operations. It is advisable to provide surge towers following blend chest and machine chest. With bland chest surge tower, it is possible to utilise better furnish component for sweetner stock. Similarly, machine chest surge tower ensures immediate utilisation of ove head stuff box recirculation stock. Polydisc saveall is ideal for fiber recovery from excess machine back water. A lot depends upon the inherent design features of sectors, unit drainage capacity, shaft, shower etc of polydisc saveall.

We are happy to state here that our polydisc saveall supplied by M/s Hedamora, Sweden, is performing excellently in terms of drainage capacity clarity and sweetner demand.

For high speed machines, extensive instrumentation for stock proportioning, consistency and level control is a pre-requisite.

Approach Flow System

The most important requirement in approach flow piping particularly from primary centriscreen accepts to headbox is absolutely burr-free smooth inner surface. To avoid recurring problem of slime breaks, it is necessary to follow supplier's recommendation of average roughness not exceeding 125 microinches.

Practically, the inner surface of piping between centriscreen and headbox should be of mirror finish. As far as possible joints should be reduced, wherever jointing is a must, it should conform to smoothnes requirement of pipe.

Deculator system achieves deaeration of stock and thus machine problems relating to foam are avoided. Further, because of high vacuum, centricleaners operation is trouble free.

Paper Machine

For high speed paper machine operation with bagasse furnish, it is recommended to opt for twin wire formers. The twin wire formers have following main advantages over conventional foudrinier machines.

— Increased productivity due to higher drainage capacity per unit area and improved process control.

*Project Executive, SPB-PC
**Quality Controller, TNPL

— Improved quality of the paper, essentially better formation, less linting, less two sidedness
— Lower power consumption
— Ease of paper making operations
— Less space requirement

Headbox

Headbox is an integral part of forming section. The most important requirement for headbox are :

— It should produce an excellent CD basis weight profile
— It should produce a very stable jet
— It should produce an excellent degree of fiber dispersion
— Easy maintenance and operation

Tamil Nadu Newsprint and Papers Limited (TNPL) has installed a Bel-Baie II former with converflow headbox. TNPL produces Newsprint, P & W, SS grades with bagasse as main furnish. The furnish constitutes of :

	Mechanical Bagasse	Chemical Bagasse	Hardwood
Newsprint	50%	35%	15%
P&W grades	—	75%	25%

With bagasse furnish it is absolutely necessary to have efficient wire cleaning and roll doctoring devices. TNPL has installed a DST self adjusting doctor to breast roll. The DST doctor consists of blade and a holder which sits tightly to doctor back. Integrated rubber seal between the holder and the back prevent water leakage. Backing and carrying wire is cleaned with VHP needle shower of 35 kg/cm². It is our experience that inefficient wire cleaning results in wire marks and water spots. Wire cleaning has been made more effective by installing sheet wetting shower in the ingoing nip of wire turning roll. The former has been provided with mist exhaust system to improve visibility in former section.

Press Section

The standard press configuration for high speed newsprint machines running on weak furnishes like bagasse is trinip. The advantages of nodraw or trinip configuration are too well known to be elaborated further. However, for pure writing and printing machine it is advantageous to go for suction pickup combined with binip press followed with straight venta press and a smoothening press. The straight venta press with top granite roll ensures smoothness for top side. Similarly, smoothening press imparts additional smoothness.

TNPL press configuration is trinip. In order to take care of low wet web strength of bagasse furnish, a steam box after first nip has been provided on suction press roll prior to second press nip. Steam connection has been provided to backwater silo. The backwater temperature is around 43°C. Back water heating assists in efficient dewatering. Since dryness at TNPL after trinip press is of the order of 41-43%, steambox has not yet been put to use.

Dryer Section

It is necessary to have single felt layout or serpentine felt for first group cylinder for weak furnishes eventhough from world standards our high speed machines are really moderate speed machines. Perhaps single felt layout provides much needed support for sheet at its weakest point and allows for easy broke disposal. Sheet flutter is obviously curtailed.

The dryer section of TNPL machine is provided with single felt layout for first group of cylinders. Further, a grooved felt roll is incorporated into first group screen to ensure better sheet support between granite roll and first dryer. The draw between press and first dryer was optimised by modifying the framing for felt roll. Thus the sheet is totally supported from the amount it is formed through to the end of first dryer section with the exception of short open draw after press. The remaining three dryer sections (two before inclined size press and one post dryer section) are arranged in double felted manner. However, the second section incorporates Beloit low profile configuration, which reduces the open draw length of the sheet. The complete dryer section is enclosed with closed hood including basement hood. Pocket ventilation ducts have been provided. Further, air deflectors in dryer screen runs reduce air currents and thus assist in avoiding sheet flutter.

Steam and Condensate System

The steam and condensate system is a cascade system with facility for switching to two/three stage cascading system depending upon production rates. For steam control, the top and bottom cylinders of first group are grouped separately. The principle being to steam the bottom dryers (low condensing rates) at a lower steam pressure than the top dryers (high condensing rates), so as to maintain the same cylinder surface temperature. Similarly, post size top and bottom cylinders are grouped separately for curl correction control. For curl correction, differential drying rates are applied as top and bottom row of post size press cylinders are each under separate pressure control and each of row has its own differential pressure control and condensate collecting vessel.

It has been found that steam and condensate system of TNPL is very efficient and steam consumption for dryer section inclusive of hood is less than 1.7 t/t of paper. TNPL dryer breaks are minimal.

Calender Section

A four roll stack with fixed queen roll is provided for TNPL machine. The calender stack has been provided with variable crown rolls at bottom and intermediate roll position. Calender stack is equipped with chilled air nozzles for maintaining good caliper profile.

Pope Reel

The pope reel design provides control of nip pressure at all stages of reel build-up. This results in good quality jumbo reels being produced.

Winder

For high speed operations, winder opeations are very critical in terms of quality and quantity of reels produced. The winder should be capable of constantly performing trouble free windup operations two and half times machine opeating speed. The final quantity of reel coming out of winder is to a great extent dependent upon winder operations.

Beloit has provided their two drum high speed winder to TNPL. The performance of winder is very good.

Process Control

TNPL has installed Model Micro 1180 AccuRay process control system for paper machine. The process control is computer based and some of the features are :

— Basis weight control
— Moisture control
— Rush/drag control
— Speed optimisation control
— Auto grade change

Hard copy report comprising	:	Reel report
		Grade report
Video display comprising	:	Process trend
		Cross machine profile
		Process summary
		Production summary

Accuray control system has been found to be very useful in day to day operations. I think the investment in process control is justified for high speed machines.

QUALITY ASSURANCE

Pulping

The first step for quality assurance lies in proper raw material management through proper depithing and wet pile preservation. Good depithing ensures the proper quality of bagasse by way of less colour reversion aud minium deterioration. For depithed bagasse it has been observed that fibre to pith ratio should be maintained 3 : 1 to ensure adequate depithing

During cooking of chemical bagasse pulp, addition of kraft liquor, temperature and retention time are closely maintained to maintain Kappa Number at 10/11 and to limit the shive count to 2—3%. The residual active alkali is maintained around 4—5 gpl to ensure uniform cooking. The bleachability for chemical bagasse pulp has been found to be quite good with total chlorine of 6.5—7.5 in C-E-H sequence. We are able to get bleached chemical bagasse pulp of 76—77% EL. The viscosity at this brightness varies between 9-11cp. Hardwood cooking is performed in batch digester with 20—22% white liquor of 20—25% sulphidity. The Kappa Number is maintained strictly around 19/21. For production of lighter gsm Printing & Writing paper. Eucalyptus grandis is found to be better than Eucalyptus tereticornis (Hybrid). The viscosity at final stage is maintained 5—7 to ensure reasonably good quality pulp suitable for refining at stock preparation and to provide adequate wet web strength.

The pH at various stages of pulp production are closely monitored for maintaining optimum viscosity and strength.

By proper raw material management, it has been possible to reasonably good quality mechanical pulp for the production of newsprint even at 700—750 m/min. Experiments are being conducted to preserve the bagasse quality during the storage life i e. over six months through applications of bio-technology.

By proper control of refining, it has been able to achieve production of mechanical pulp with reasonable strength and good opacity. The newsprint opacity (printing) of 92/93% has been achieved which conform to international specifications.

In order to preserve maximum strength of mechanical and chemical bagasse pulp any post refining at stock preparation has to be excluded.

The final brightness of mechanical bagasse pulp is highly dependent on age of bagasse. Depending upon the age of the baggase, the brightness of mechanical bagasse has been achieved 35–50% EL with 1.0–1.5% peroxide. The typical properties of TNPL newsprint, creamwove and maplitho (SS) are given in Table-1, Table-2 and Table-3.

Paper

Due to twin wire configuration following advantages have been experienced.

1 Less two sidedness in paper.

2 Good formation

For day to day quality monitoring, following features have been found to be more useful for maintaining paper quality.

1 Control of jet/wire speed ratio for monitoring ultimate paper properties like breaking length. Depending upon the grammage and properties required for paper the MD : CD breaking length can be varied from 2.5–3.1. This has attributed to better operation (high speed) at winder.

2 Comparatively low tear of paper due to chemical bagasse pulp is compensated by hardwood pulp with relatively higher tear.

3 Less moisture variation due to Accu Ray control which keep the paper curl free. We do not have any curl even for our surface coated paper for which production has been taken up very recently. Response from the printers is also quite good.

4 The cascade control of steam in drying section also contributes to maintain uniform moisture.

5 Bulk of the paper is comparatively low due to low bulk of chemical bagasse.

6 The opacity and other test parameters have been able to meet the ISI specifications for all varieties of paper.

Freeness, Consistency and Fiber Classification

In general, freeness at machine headbox is attained around 260 csf for Printing & Writing paper. The converflow box freeness is maintained around 100 csf to ensure better runnability. The consistency at converflow is maintained at 1.0–1.2% for Newsprint and 0.9–1 0% for Printing & Writing paper.

Printing Result

The print quality, show through, ink absorption etc have been found to be quite encouraging for making high quality Printing & Writing paper and are quite comparable to others. It has been able to achieve higher VVP about 2200–2800 for creamwove paper which proves beyond doubt that such paper is quite suitable for high speed and high quality printing.

Wet Web Strength

The wet web strength for TNPL Newsprint furnish is 0.6–0 65 Nm/g. and for Printing & Writing paper the same varies to 0.9–1.0 Nm/g.

TABLE—1
PROPERTIES OF CREAMWOVE PAPERS

S No.	Particulars	Unit	TNPL	Mill-A	Mill-B	Mill-C	Mill-D	Mill-E	Mill-F	Mill-G
1.	Basis Weight	g/m^2	60	60	62.5	59.5	60	57	60	62/60
2.	Caliper	mic	78/85	80	85	87	78	89	—	103
3.	Bulk	cc/gm	1.30/1.42	1.33	1.36	1.45	1.34	1.47	—	1·59
4.	Ash	%	11.0	16-18	15.8	6.0	—	11.0	—	—
5.	Moisture	%	5.6	4.5	—	—	—	—	—	—
6.	Brightness	%EL	71.7	70 6	62 2	72 2	71.5	67.9	63.1	58.5
7.	Yellowness	%	–4.0	–1.1	3.5	–4.6	—	–3.3	–18.7	–6.7
8.	Opacity	%	89 5	88.0	95.2	95.0	90 0	92.4	98.1	98 7
9.	Breaking									
	Length–MD	metre	6120	4900	3720	—	3530	3430	—	4090
	–CD	metre	2570	2500	2250	—	2380	1790	—	2030
10.	Tear Factor–MD	metre	37	50/60	53	—	29	45	—	44
	–CD	metre	47	60	54	—	33	53	—	53
11	Burst Factor	Nos	18	14	13	—	13.1	16	—	14
12	D F	Nos	15/10	10/5	—	—	4/3	—	—	8/4
13.	Smoothness	m/min	220/90	140/120	260/160	130/160	530/390	250/150	290/465	850/600
14	Porosity	m/min	100	575	910	850	595	500	905	1000
15.	Cobb Sizing	g/m^2	25/24	18/20	—	—	18/19	—	—	30/29

TABLE—2
PROPERTIES OF MAPLITHO & OFFSET PAPERS

S. No.	Particulars	Unit	TNPL SS	TNPL SS	Mill-A Maplitho	Mill-C Offset	Mill-E Maplitho	Mill-F Maplitho
1.	Substance	gsm	60.0	70.0	81.0	57.9	64 8	63.0
2.	Caliper	mic	71	84	99	76	93	78
3.	Bulk	cm^3/gm	1.20	1.20	1.22	1.31	1.44	1.24
4.	Ash	%	17.5	16.7	18.0	12.5	12 0	15 2
5.	Smoothness	ml/min	150/85	175/90	160/90	170/90	180/125	90/75
6.	Porosity	ml/min	90	60	310	920	690	430
7.	Brightness	%	72 8	73.5	71.0	82 0	71 0	74.7
8.	Opacity (print)	%	90	91	97.2	83.1	96.6	92 5
9.	Yellowness	%	–13 0	–13.8	–12.9	–0.0	–10.8	–4.0
10.	Shade		Blue	Blue	Blue	Whitish	Pink	Pink
11.	Cleanliness		Fair	Fair	Good	Good	Satisfactory	Good
12.	Formation		Good	Good	Cloudy	Good	Cloudy	Fair
13.	End User		Varnishable lable printing	Varnishable calender	Album Xerox paper varnishing	For making diary	Lable printing	Lable printing 70 gsm for calender

TABLE—3

COMPARISON OF BAGASSE NEWSPRINT WITH WOOD BASED NEWSPRINTS

TYPE :		Softwood Newsprint	Hardwood Newsprint	Bagasse Newsprint	Bagasse Newsprint
SOURCE :		Canada (Powel River)	India (Kerala)	Argentina (Tucuman)	India (TNPL)
Basis weight	gsm	48.2	51.4	49.6	50.6
Caliper	mic	85	81	67	85
Sheet Ash	%	1.0	3.0	14	9.2
Breaking length (MD)	metres	4450	5970	4150	3520
Burst factor		12	20	11	11
Tear factor (CD)		52	56	61	44
Printing opacity	%	93.5	91	88	93.5
Scattering Coefficient	cm^2/g	434	401	437	450
Absorption Coefficient	cm^2/g	47	43	26	50
Brightness	°GE	58	48	59	50.5
Furnish Composition		TMP 85% SBK 15%	CMP 70% HWP 30%	SCBP 75% GWP 15% SBK 10%	MBP 50% CBP 35% HWP 15%
Machine speed	mpm	1100	600	600	630

Note : TMP = Thermo Mechanical Pulp
CMP = Chemi Mechanical Pulp
SBK = Semi Bleached Kraft
MBP = Mechanical Bagasse Pulp
SCBP = Semi Chemical Bagasse Pulp
HWP = Hard Wood Pulp (Bleached)
CBP = Chemical Bagasse Pulp
GWP = Ground Wood Pulp

THE IMPROVEMENT OF CAUSTICIZING SYSTEM IN A BLEACHED BAGASSE PULP PLANT

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ABSTRACT

Causticizing is a link of the close cycle of the recovery system in the pulp and paper industries. It affects the stability of pulp quality and the cost of pulp manufacturing. Troublesome and factors which influence the efficiency during processing were throughly studied. Improvement from various points has been taken which results in certain increase of efficiency as well as yield.

FOREWORD

Sulphate process is adopted by Ping-tung Bagasse Pulp Factory, TSC, with a daily capacity of 300 ADMT bleached bagasse pulp. Generally, ash and SiO_2 contents in bagasse are higher than that in wood for pulp processing. and, in addition, bagasse from our sugar mills contains more trash due to machinery harvesting. Therefore, a series of trouble occurred in the chemical recovery system, including scale forming in evaporator, incomplete burning of black liquor, low efficiency of causticizing and poor quality of quick lime calcined from the system, which affect normal operation. In order to solve these problems and, also, to prevent pollution and save production cost, this improvement program was carried out.

BRIEF INTRODUCTION TO CAUSTICIZING SYSTEM

The causticizing system adopted by Pingtung Bagasse Pulp Factory is given in Figure 1. and Figure 2. respectively.

Figure 1. PREPARATION OF GREEN LIQUOR

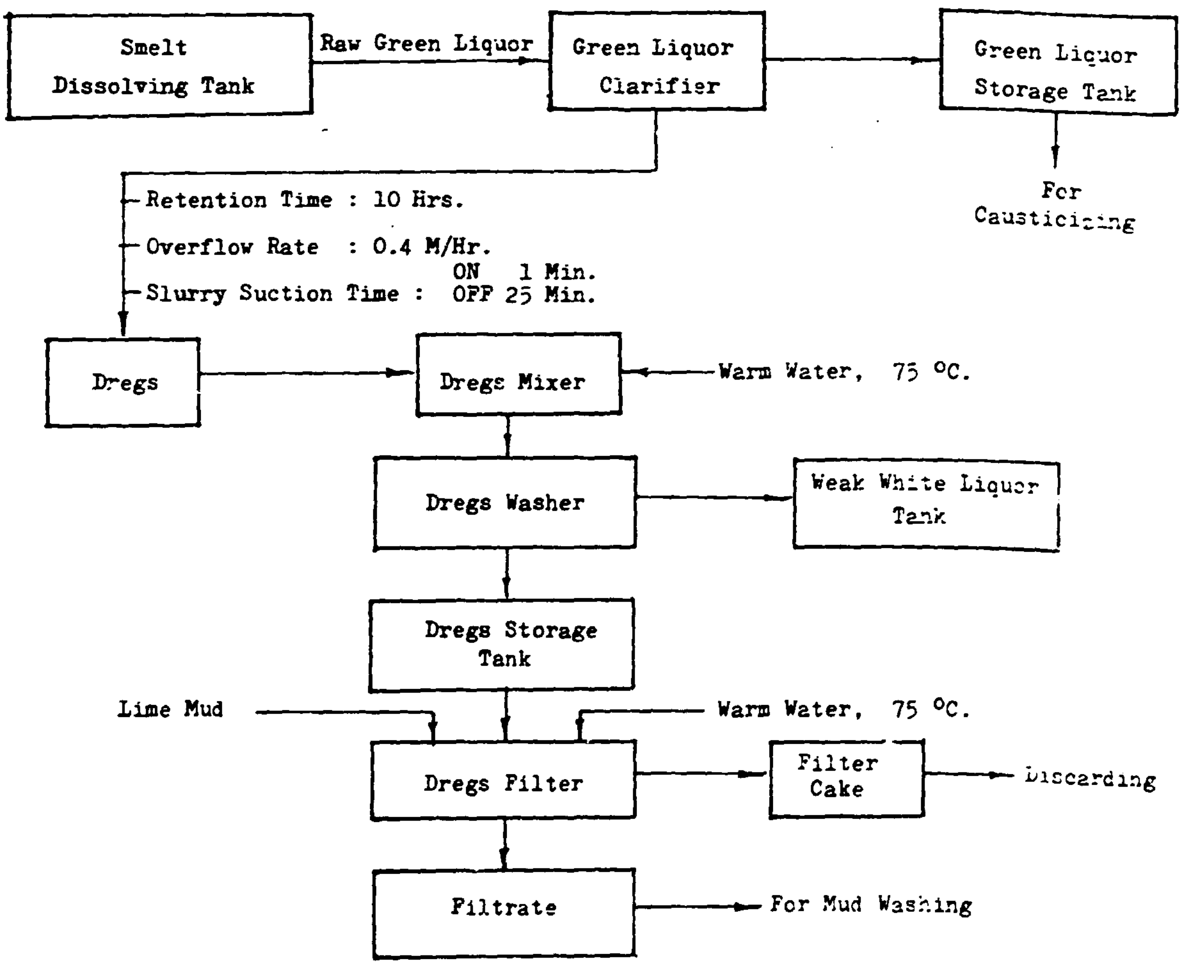
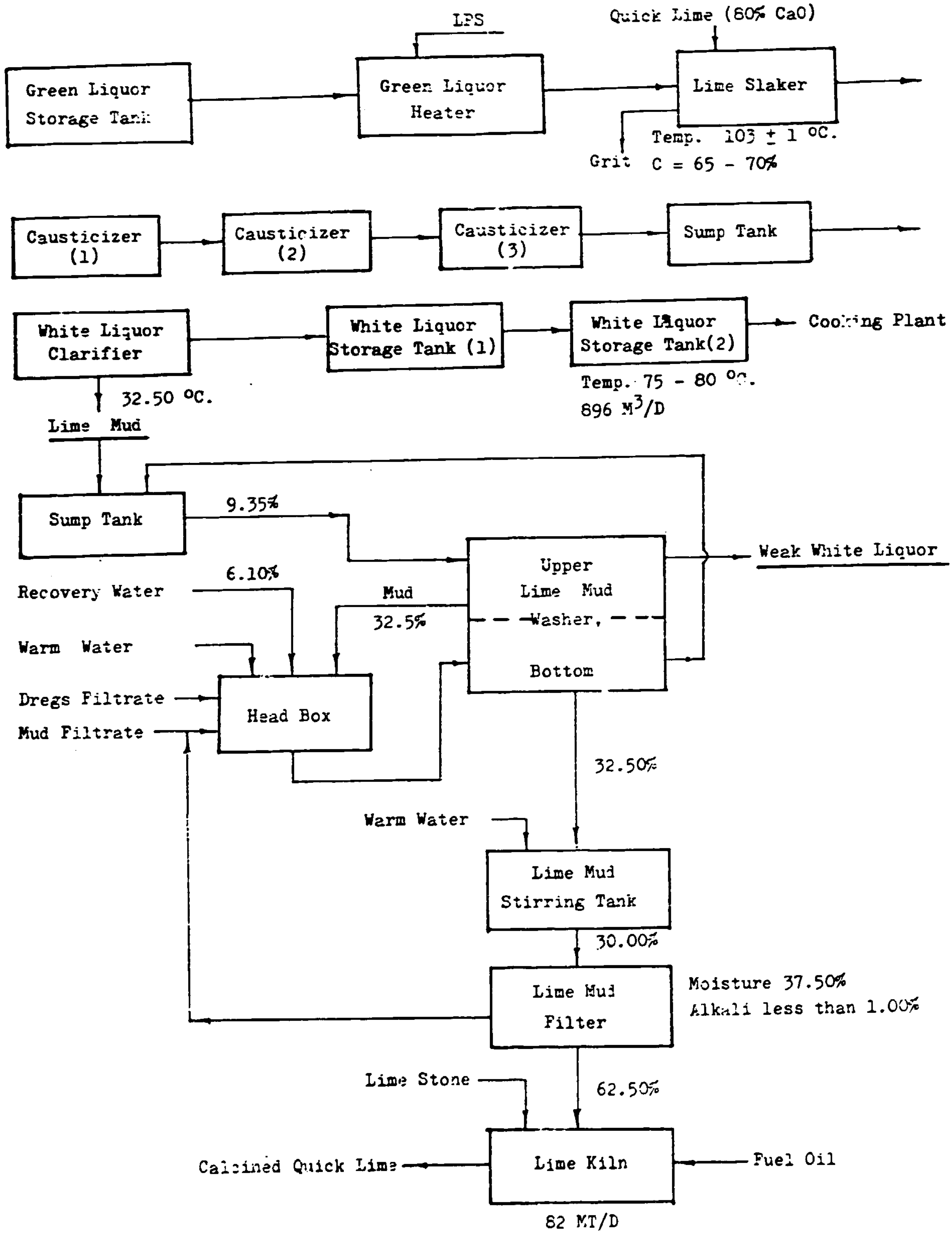


Figure 2. FLOW DIAGRAM OF CAUSTICIZING

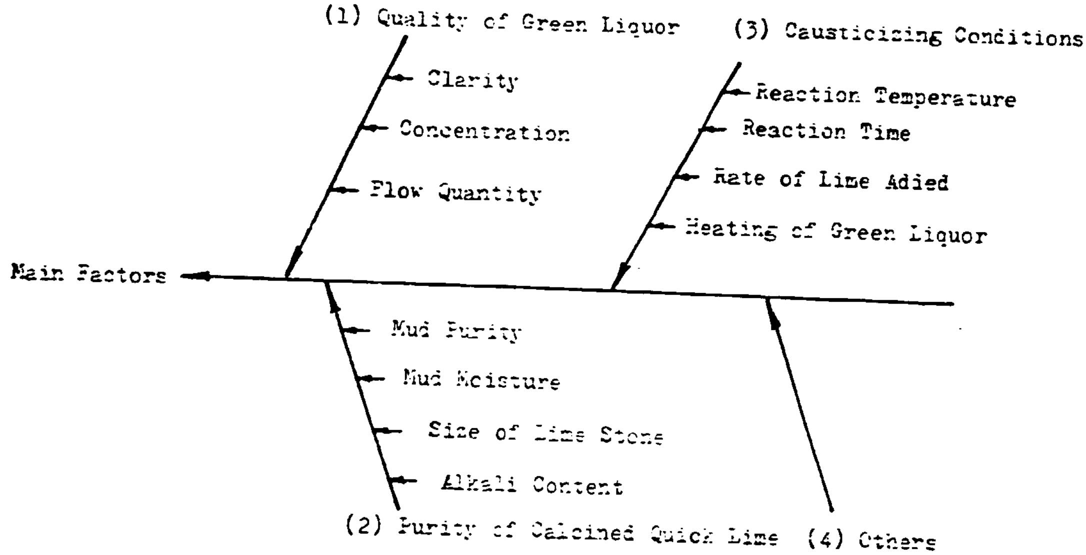


TROUBLES OCCURRED IN CAUSTICIZING SYSTEM

1. The heater for green liquor was frequently choked by scale.
2. Agitator trouble occurred in first causticizer.
3. Causticizing efficiency of white liquor appeared rather low resulted in higher make-up of chemicals.
4. Rake trouble at dregs washer.
5. Rake trouble at white liquor clarifier.
6. High alkali content(3%) and moisture(50%) in dehydrated dregs.
7. Incomplete burning of lime stone, the particle size of which is 6 - 15 m/m.
8. Frequent choking at the inlet of the wet type dirt remover.
9. Low purity of quick lime calcined from lime stone of poor quality.
10. Total alkali in green liquor was unstable.

INFLUENTIAL FACTORS OF CAUSTICIZING EFFICIENCY AND IMPROVING MEASURES

Low causticizing efficiency will result not only in poor pulp quality but also in higher production cost as well. The influential factors are shown in the following fish-bone chart:



QUALITY OF GREEN LIQUOR

1. Green liquor is the major material for causticizing. Raw green liquor contains large amount of suspending impurity called dregs which must be removed, otherwise, it will add mechanical load in the causticizing system.
2. Generally speaking, raw green liquor contains around 600 - 1200 ppm of dregs. After clarifying for 10 hours, it will reduce to less than 100 ppm. And, around 4 kgs of dregs turned out by per ton of air dried pulp. However, raw green liquor in Ping-tung Pulp Factory carried around 1900 ppm of dregs. After clarifying, some 300 ppm of dregs was left. As a result, around 8.5 kgs of dregs turned out by per ton of pulp. There is still much room for improving clarification of raw green liquor so as to reduce choking of green liquor heater by scale.
3. High SiO_2 content and high viscosity of raw green liquor may be the main factors affecting clarifying efficiency. In addition, it may be better to instal a sump tank before green liquor clarifier to accelerate sedimenting of dregs.
4. Actual measures to be taken to improve raw green liquor clarification, as follows:
   1). Instal a sump tank, 500 M^3, before clarifier.
   2). Judging from Stokes' law:

$$V_s = \frac{(\rho_s - \rho_l) \cdot D_s^2 \cdot g_c}{18\mu}$$

where, V_s = Solid sedimenting speed
ρ_l = Specific gravity of liquid
ρ_s = Specific gravity of solid
D_s = Diameter of solid particle
g_c = Gravity accelerating velocity
μ = viscosity of liquid

Two measures can be taken to accelerate sedimenting of solid, namely:

a. Adding of coagulant to raw green liquor so as to increase ρ_s and D_s values.

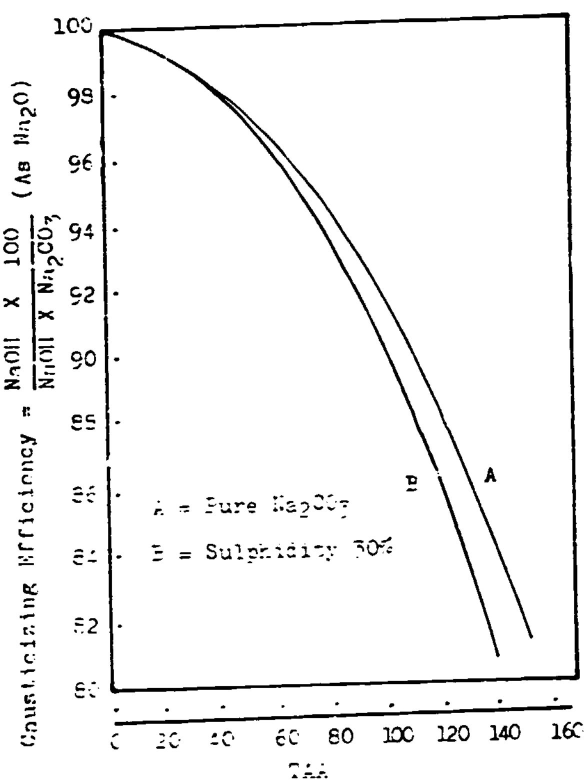
d. Rising of raw green liquor temperature and /or lower its concentration in order to reduce ρ_l and μ values.

c. At present, no suitable coagulant is available at Ping-tung Pulp.

the best way we can take is to lower green liquor concentration from 115 g/l to 105 g/l as Na_2O, so that the clarity of clarified green liquor can be reduced to around 200 ppm.

d. Figure 3. shows that the lower the concentration of green liquor, the better causticizing efficiency will be. Comparison of causticizing efficiency and green liquor concentration before and after improvement is given in Table 1.

Figure 3. RELATIONSHIP BETWEEN CAUSTICIZING EFFICIENCY AND GREEN LIQUOR CONCENTRATION.



e. Impurities in green liquor usually come from make-up sodium sulfate, lime stone and bagasse trash, etc. Especially, suspended black matter is a big trouble for sedimentation, which is composed of uncombusted carbon, Fe, Si, Ca, Al, Mg and sulphides. Plans are under taken by Ping-tung Pulp to add $Ca(OH)_2$ as an aid to accelerate sedimenting, and /or to adopt two-stage causticizing method.

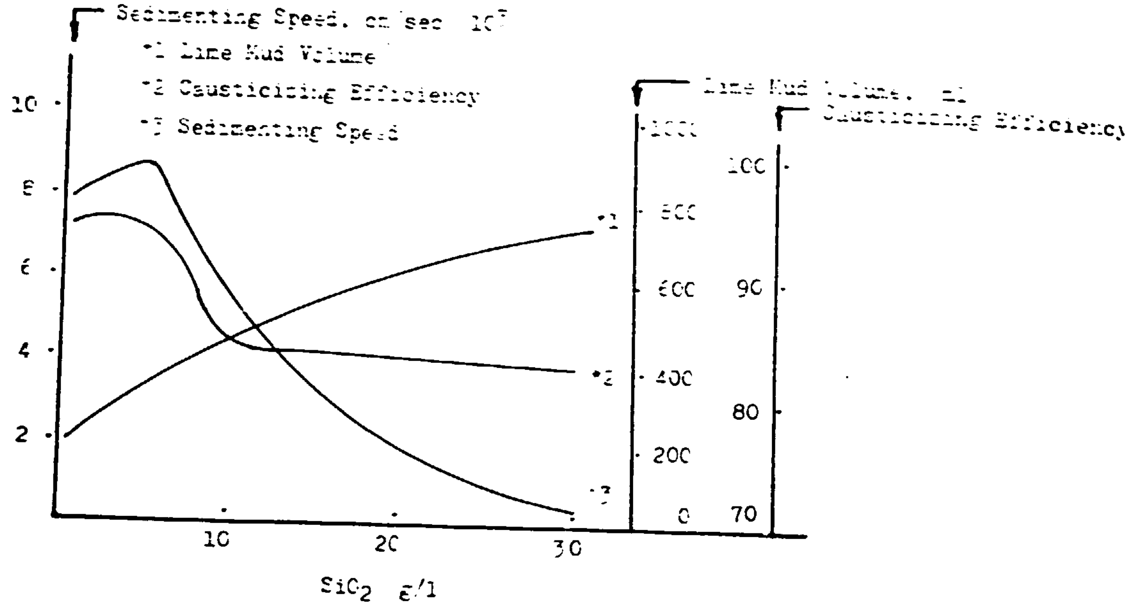
PURITY OF CALCINED QUICK LIME:

1. In the process of causticizing, large amount of lime is required should purity of calcined quick lime be poor, as a result, big loss of lime due to grit and low recovery of white liquor due to lime mud after causticizing will be occurred. It will bring various troubles as agitator trouble in No. 1 causticizer and rake troubles in white liquor clarifier, lime mud washer and so forth, resulting in higher fuel oil consumption in lime kiln operation.
2. Figure 4. shows that how purity of calcined quick lime affect causticizing efficiency, mud sedimenting speed and mud volume. SiO_2 content in green liquor of bagasse pulp plant usually exceeds 6 - 8%, as a result, from Figure 4, poor causticizing efficiency, slow sedimenting and increase of mud volume are observed.
3. To stabilized purity of calcined quick lime, Ping-tung Pulp is taking the following measures according to its influential factors:

Table 1. COMPOSITION OF WHITE LIQUOR

Item	Green Liquor Concentration, g/l Na_2O 115(Original)	105(Improved)
NaOH g/l as Na_2O	68	68
Na_2S g/l as Na_2O	17	17
Na_2CO_3 g/l as Na_2O	30	20
Total Alkali (TA)	115	105
Causticizing Efficiency, %	69.4	77.3
Sulphidity, %	20	20
Active Alkali, g/l as Na_2O	85	85
Activity, %	73.9	81

Figure 4. SiO_2 CONTENT OF GREEN LIQUOR VS CAUSTICIZING EFFICIENCY, SEDIMENTING SPEED AND LIME MUD VOLUME.



1). Increase lime mud discharging rate from 20% to 30%. The daily operation, 50MT per day, can be completed in three cycles rather than five cycles. Some 25 MT of lime stone and 10 MT of quick lime is required daily as make-up so as to maintain purity of lime mud higher than 85%.

2). The water content of lime mud from vacuum filter is usually as high as 40 - 50%, which inevitably causes high consumption of fuel oil in rotary kiln and results in lower calcining efficiency and, finally, poor causticizing efficiency. Therefore, size of lime stone for make-up lowered from 6 - 15 m/m to 0.8 - 5 m/m, and, in addition, a mud dryer is under installing which is expected to lower lime mud moisture to around 15% by the available heat in flue gas at a temperature of approximately 350 - 450 oC, so that calcining efficiency is to be increased from 80% up to more than 90%.

CAUSTICIZING CONDITIONS

1. Actually, the reaction of slaking and causticizing overlap and parts of the causticizing occurs almost simultaneously with the slaking, as follows:

$$CaO + H_2O \rightarrow Ca(OH)_2 + 270 \text{ Kcal/kg CaO}$$

$$Ca(OH)_2 + Na_2CO_3 \rightarrow 2NaOH + CaCO_3$$

2. Conditions of causticizing reaction in Ping-tung Pulp were improved and selected as follows:
   1). Reaction temperature: 103 ± 1 oC., check per hour.
   2). Agitation power:
       Slaking : 0.75 KW/M3
       Causticizing : 0.28 KW/M3
   3). Adding rate of quick lime: Causticizing efficiency of reacting liquid in slaker at 65 - 70%, test every hour.
   4). Temperature of green liquor: 92 - 94 oC, controlled with direct heating heater, check every hour.
   5). Reaction time: Increased from 108 minutes up to 150 minutes after installing of another (third) causticizer resulting in an increase of the over-all causticizing efficiency by 10%.

OTHER IMPROVING MEASURES

1. Strict quality control of purchased lime stone and/or quick lime.
2. Preventing of sand encluded into lime stone.

RESULTS OF THE IMPROVEMENT

Table 2. CAUSTICIZING EFFICIENCY (REFERRED TO AS C.E.)

	White Liquor				
	NaOH g/l as Na_2O	Na_2CO_3 g/l as Na_2O	Total Alkali.g/l as Na_2O	C.E.	Yield %
Original	74.96	29.09	103.83	71.96	69.09
After Improved	86.11	21.01	103.65	80.68	74.80

Table 3. UNIT CONSUMPTION OF RAW MATERIAL PER 1 M^3 OF WHITE LIQUOR (AA 85g/l as Na_2O)

	Purchased Lime (kgs)	96% Lime Stone (kgs)	45% Liquid Soda (kgs)	Fuel Oil (l)
Original(A)	25	27.50	60.50	21.64
After Improved(B)	14	34.20	26.54	20.97
(B) - (A)	(-)11	(+) 6.70	(-)33.96	(-) 0.67

PROFITS:

Based on 1 M^3 white liquor (AA 85% as Na_2O):

1. Increase of causticizing efficiency from 71.69 to 80.68%:

   $(29.09 - 21.01) \times \frac{80}{62}$ = 10.31 kgs .... as 100% NaOH

   $\frac{10.31}{0.45}$ = 22.91 kgs .... as 45% Liquid Soda

   Profits = NT$ 5.00/kg X 22.91 = NT$ 114.56

2. Raw material consumption:

   1). Purchased quick lime: NT$ 2.80/kg X 11 kg = NT$ 31.46 (-)

   2). Lime stone: NT$ 0.95/kg X 6.7kg = NT$ 6.37 (-)

   3). Liquid soda: NT$ 5.00/kg X 33.96 kg = NT$ 169.80 (+)

   4). Fuel oil: NT$ 7.60/ l X 0.67 l = NT$ 5.09 (+)

   Total NT$ 199.98 (-)

3. Increasing yield from 69.09 to 74.80%:

   Some more 1257 M^3 of white liquor will be turned out per month with a profit around NT$ 1,595,260.00

CONCLUSION

1. After improvement of causticizing system, not only productivity was increased but also better quality of white liquor achieved as well.

2. Measures for removing of SiO_2 from gre liquor will be tried by Ping-tune Pul for further improvement.

3. After installing of dryer for lime su higher calcining efficiency and less fu oil consumption are expected.

Towards effluent-free production of bagasse and eucalyptus pulps for newsprint

Thomas Granfeldt, Ove Danielsson, Solveig Norden, and K. Gunnar Ryrberg

An acceptable newsprint can be produced from a mixture of 60% bagasse chemical pulp and 40% eucalyptus chemimechanical pulp.

Earlier papers (1, 2) showed that bagasse is not an ideal raw material for producing newsprint because it was not possible to make a mechanical or chemimechanical pulp from bagasse that displayed a suitable combination of light scattering coefficient and pulp strength. Instead, the suggested approach was to use chemical pulp from bagasse and chemimechanical pulp from local hardwoods.

Semichemical and chemical bagasse pulps are often bleached with chlorine or hypochlorite, or both. Chemimechanical hardwood pulps are usually bleached with peroxide, but in some cases with hypochlorite. Bleaching with chlorine-containing chemicals such as hypochlorite produces chlorinated organic compounds that can be persistent and lipophilic.

Oxygen delignification has been developed for wood chemical pulps (3). This process makes it possible to reduce the lignin content of unbleached chemical pulp and diminish the effluent load by about 50% without detriment to the pulp quality.

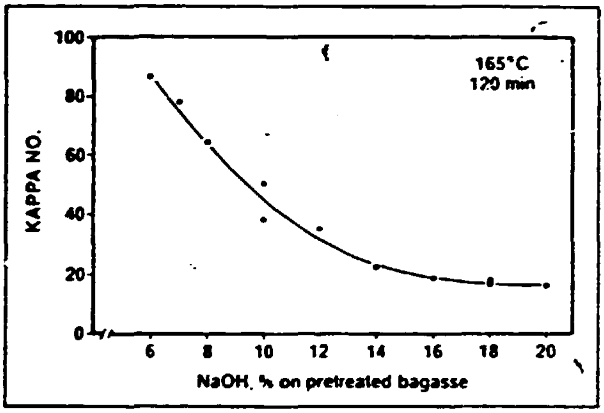
There were two purposes for the laboratory study presented here. One was to produce bleached bagasse chemical pulp and eucalyptus chemi-thermomechanical pulp (CTMP) with potentially little or no effluent load on the receiving waters. The other was to show that a mixture of these pulps should be able to produce an acceptable newsprint.

Bagasse chemical pulp

The discharge from the bleach plant determined, for instance, as chemical oxygen demand (COD), biological oxygen demand (BOD), color, or AOX (chlorinated organic substances), is almost proportional to the lignin content of the pulp to be bleached. Prolonged delignification in the closed part of the mill is thus advantageous environmentally, either in the soda cook or in the oxygen delignification stage. However, if the length of such delignification is prolonged too far, there will be a severe attack on the carbohydrates in the pulp.

In the laboratory study, bleached bagasse pulps suitable for newsprint were produced with brightnesses of 60-70% ISO. The goal was to produce a pulp with as high a yield as possible, with a suitable combination of mechanical and optical properties and with a low effluent load from bleaching.

1. In soda pulping, the kappa number of the bagasse pulp can be reduced to about 20. (Bagasse to liquor ratio of 1:4)



Soda pulping

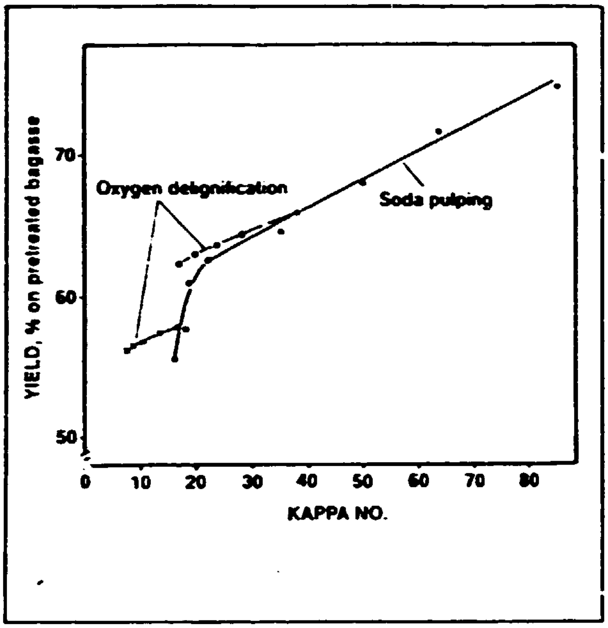
Soda pulping is a common process for producing bagasse pulp. Our results show that the kappa number of the bagasse pulp can be reduced to about 20. A further reduction requires a high NaOH charge (Fig. 1). The yield loss per kappa number unit also increases substantially at kappa numbers below 20 (Fig. 2).

Oxygen delignification

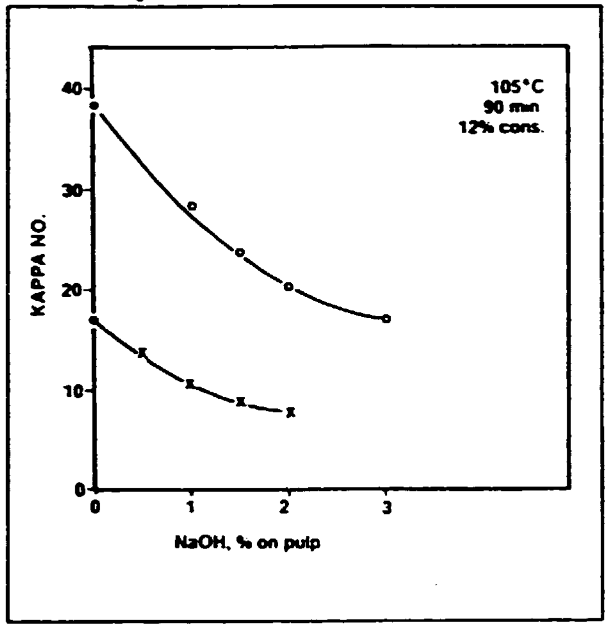
Figure 2 shows results from oxygen delignification of two bagasse pulps with kappa numbers of 38.4 and 16.7

Granfeldt is senior research associate of R&D for high-yield pulping. Danielsson is the director of R&D for high-yield pulping. Norden is senior research associate of R&D for chemical pulping, and Ryrberg is vice president of marketing at Sunds Defibrator AB, S-851 94 Sundsvall, Sweden.

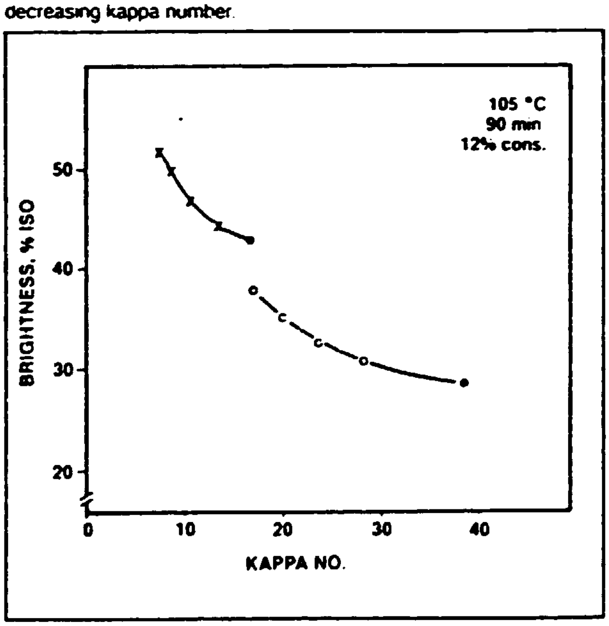
2 For soda pulping, the yield loss increases substantially at kappa numbers below 20



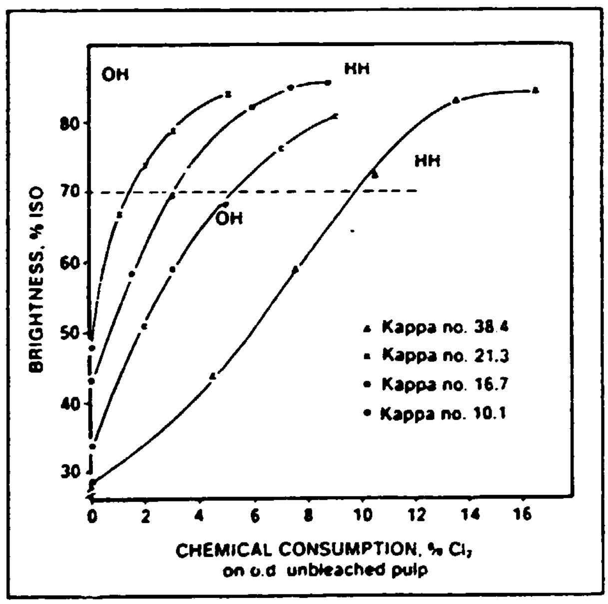
3. In the oxygen-delignification stage, the kappa number levels off at about 50% delignification



4. The brightness of the oxygen-delignified pulp increases with decreasing kappa number.



5. Relationship between brightness and hypochlorite consumption



Oxygen delignification results in a higher pulp yield than prolonged cooking, especially at low kappa numbers.

The influence of the NaOH charge in the oxygen-delignification stage is shown in Fig. 3. The drop in kappa number levels off at about 50% delignification. A further reduction of the kappa number can only be obtained by a substantial increase in the NaOH charge.

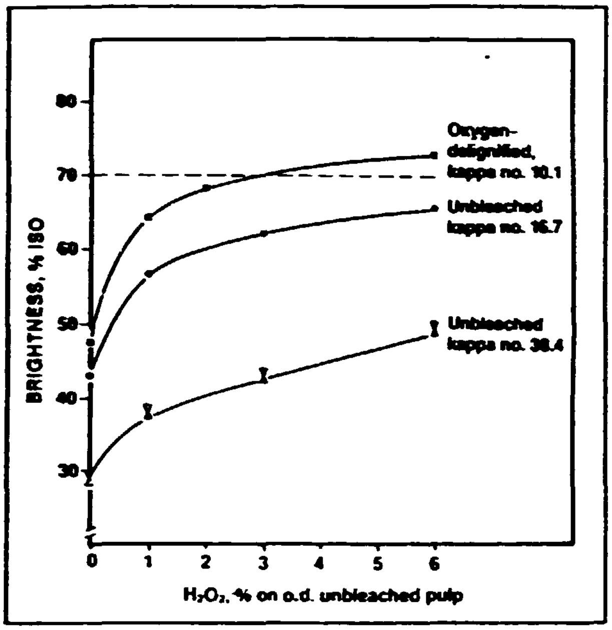
The brightness of the oxygen-delignified pulp increases with decreasing kappa number (Fig. 4).

Bleaching

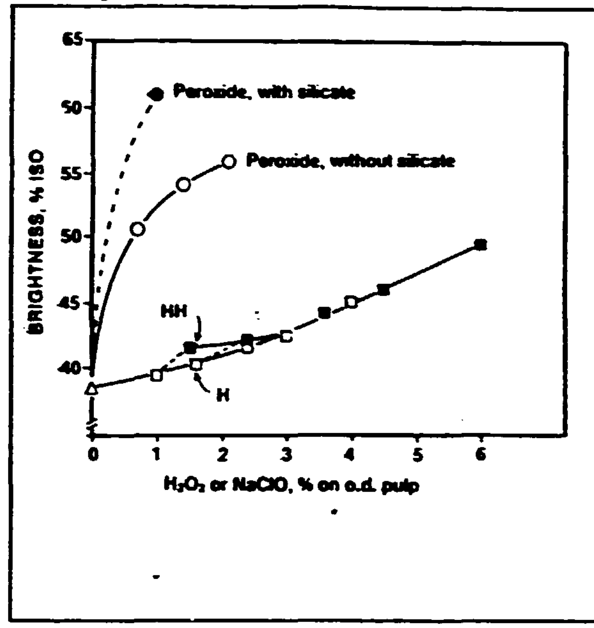
The consumption of bleaching chemicals to reach a certain brightness depends on the kappa number of unbleached or oxygen-delignified pulp. The relationship between brightness and hypochlorite consumption for two pulps bleached with the sequences HH (hypochlorite, hypochlorite) and OH (oxygen, hypochlorite) is shown in Fig. 5. Brightness values up to about 83% ISO have been reached.

The hypochlorite consumption to reach 70% ISO brightness varies from 9.4% on oven-dried (o.d.) pulp for the unbleached pulp with a kappa number of 38.4 to 1.3% on o.d. pulp for the oxygen-delignified pulp with a kappa number of 10.1. These figures are valid for the bleaching of well washed pulps.

6. Peroxide bleaching (without silicate) of two soda pulps and one oxygen-delignified soda pulp



7. A higher peroxide charge is needed to reach the target brightness if bleaching is carried out without silicate



If a bleaching sequence without chlorine chemicals could be used, it would be possible in principle to close the water circuit in the whole pulp production plant.

Results from peroxide bleaching (without silicate) of two soda pulps and one oxygen delignified soda pulp are shown in Fig. 6. To reach a brightness of 70% ISO, the soda pulps had to be oxygen delignified to a kappa number of 10 before the peroxide bleaching. A brightness of 60% ISO could be reached just by the peroxide bleaching of a soda pulp with a kappa number of 20.

Bleaching effluents

Table I presents analysis data for the effluent from hypochlorite and peroxide bleaching. Pulping to a low kappa number gives a low effluent load from the bleach plant, particularly when the pulping is combined with oxygen delignification.

At the same kappa number, both COD and BOD are higher in the effluent from hydrogen peroxide bleaching than in the effluent from hypochlorite bleaching. This higher concentration is not a serious matter environmentally because the bleaching effluent can be dealt with, but it does indicate a higher yield loss during peroxide bleaching.

Physical properties of bleached bagasse pulps

The physical properties of four bleached pulps were tested according to ISO procedures (International Standards Organization). The results are presented in Table II. There were no big differences in the pulp properties between pulps with different unbleached kappa numbers. Furthermore, only small differences were evident between pulps bleached with the sequences HH and OH.

Eucalyptus CTMP

The CTMP was produced from Indian-grown eucalyptus (*Eucalyptus grandis*), according to the cold soda method. By charging 5% NaOH and 2% Na_2SO_3 on o.d. wood pulp, the energy consumption was 770 kW·h/a.d. metric ton to reach a freeness of 385 mL CSF. The treatment resulted in an estimated pulp yield of 86% and a brightness of 38.5% ISO.

Bleaching

It was necessary to bleach the CTMP to a brightness of 55–60% ISO for the newsprint furnish. Two bleaching chemicals, peroxide and hypochlorite, were evaluated.

In peroxide bleaching systems, sodium silicate is normally added to stabilize the peroxide, but in this case sodium silicate was not used, so that all or part of the effluent from the CTMP plant could be sent to the bagasse plant for recovery. The wash water volume had to be kept low, and the presence of silicate was unacceptable.

Bleaching without silicate means that a higher peroxide charge is needed to reach a certain brightness. As Fig. 7 shows, about 2% peroxide was charged to reach a brightness of 55% ISO. Bleaching of common eucalyptus CTMP in the presence of silicate has given 60% ISO brightness (4).

A single-stage hypochlorite bleaching of CTMP charging with 4% NaClO resulted in a fairly low brightness increase of only 6.5 percentage units (Fig. 7). In an effort to further increase the brightness, a second-stage hypochlorite bleaching was also carried out, charging with an additional 2% NaClO. As a result, a maximum brightness of about 50% ISO was reached. To reach the target brightness of 55% ISO, a 12-15% charge of hypochlorite is required.

Bleaching effluents

Table III presents data on the CTMP effluent. Only about 15% of COD originates from the peroxide or hypochlorite bleaching because the main effluent source is the CTMP process itself. Compared to peroxide bleaching, bleaching

I. Bleaching to a brightness of 70% ISO with the sequences HH, OH, and P

	Kappa no. 16.7			Kappa no. 38.4	
	HH	OH	P	HH	OH
Kappa no. after oxygen delignification	...	10.1	10.1	...	21.3
NaClO charge, %	2.9	1.3	...	9.4	4.9
H_2O_2 charge, %	...	...	2.8	...	...
COD, kg/ton	18	9	34	90	39
BOD_7, kg/ton	5.2	3.3	8.4	16.4	8.6
AOX, kg/ton	0.6	0.3	...	5.0	2.3
Color, kg/ton	6.7	...	...	20.0	7.4

P = hydrogen peroxide.

II. Physical properties of bleached bagasse pulps

	Kappa no. 38.4		Kappa no. 16.7	
	HH	OH	HH	OH
Intrinsic viscosity, dm^3/kg	740	770	820	870
Freeness, mL CSF	379	477	433	466
Density, kg/m^3	743	740	721	757
Tensile index, kN·m/kg	60.7	58.2	56.7	56.1
Tear index, N·m^2/kg	4.79	5.04	4.92	4.92
Light scattering coef., m^2/kg	19.2	21.9	20.5	22.2
Light absorption coef., m^2/kg	1.12	0.65	1.10	0.60
Opacity, %	73.2	71.9	74.7	72.0
Brightness, % ISO	71.5	72.8	73.4	74.5

with hypochlorite results in an effluent containing chlorinated organic substances (AOX).

Physical properties of bleached CTMP

Physical and optical properties were tested on peroxide- and hypochlorite-bleached pulp. Table IV shows that with the exception of brightness, no important differences were found due to the bleaching methods used, despite the high chemical charges during hypochlorite bleaching. At a freeness of about 350 mL CSF, obtained with 770 kW·h/a.d. metric ton of refining energy, the pulps showed an acceptable combination of strength and optical properties. Additional refining would have resulted in improved physical and optical properties.

Bagasse chemical pulp blended with eucalyptus CTMP

Mixtures of bagasse chemical pulps (bleached OH) and eucalyptus CTMP (bleached HH and P) were tested for their suitability for newsprint. The testing was carried out on laboratory sheets, and the results are presented in Table V.

Figure 8 shows the effect of varying the furnish composition on brightness and opacity. For a mixture of 60% bagasse and 40% eucalyptus CTMP, the brightness is about 58% ISO with hypochlorite-bleached CTMP and 62% ISO with peroxide-bleached CTMP.

The opacity for the same pulp mixtures were 89% and 85%, respectively, measured for papers with an o.d. weight of 60 g/m². For comparison, a Scandinavian newsprint has an opacity of 94%, while the recommendations of the Food and Agricultural Organization of the United Nations (FAO) conference in Cairo in 1965 were for a minimum opacity of no less than 86% for papers containing bagasse (*2*).

If a brightness of 55% ISO can be accepted, the FAO recommendations can be met with the 60% bagasse and 40% eucalyptus furnish composition at sheet weights of 52 g/m². From a mixture of 40% bagasse chemical pulp and 60% eucalyptus CTMP, 52-g/m² papers can easily be produced with 86% opacity at 60% brightness, as well as 45-g/m² papers with 86% opacity at 55% brightness.

Figure 8 also shows the tensile index for the different furnish compositions. For the 60% bagasse and 40% eucalyptus furnish, the tensile index is 42-46 kN·m/kg, which corresponds to about the same strength as Scandinavian newsprint. This high strength would permit the addition of some clay to improve the opacity (*2*).

Table V shows that the mixtures exhibit similar

III. Eucalyptus CTMP effluents

	Unbl.	Bleaching sequence P	Bleaching sequence HH
H_2O_2 charge, %	...	2	...
NaClO charge, %	...	...	6
NaOH charge, %	...	2	0.8
COD, kg/ton	209	29	11
BOD_7, kg/ton	96	4	4
Color, kg/ton	317	11	5
AOX, kg/ton	0	0	0.4

P = hydrogen peroxide.

IV. Physical properties of bleached eucalyptus CTMP

	Peroxide	Hypochlorite, hypochlorite
H_2O_2 charge, %	2	...
NaClO charge, %	...	6
NaOH charge, %	2	0.8
Freeness, mL CSF	355	359
Estimated yield, %	84	85
Density, kg/m³	395	402
Tensile index, kN·m/kg	22.8	25.0
Tear index, N·m²/kg	2.5	3.0
Light scat. coef., m²/kg	45.8	43.3
Opacity, %	93.5	94.6
Brightness, % ISO	54.7	49.3

V. Physical properties of pulp mixtures

	40% HH CTMP/ 60% bagasse	60% HH CTMP/ 40% bagasse	40% P CTMP/ 60% bagasse	60% P CTMP/ 40% bagasse
Density, kg/m³	570	475	580	490
Tensile index, kN·m/kg	43	34	43	34
Tear index, N·m²/kg	5.1	4.6	5.2	4.4
Light scat. coef., m²/kg	33	37	32	39
Light abs. coef., m²/kg	2.5	2.7	1.5	1.9
Opacity, %	89	91	85	90
Brightness, % ISO	59	55	62	59

The bagasse pulp was bleached with the sequence OH. CTMP was bleached with a hydrogen peroxide (P) sequence or a hypochlorite, hypochlorite (HH) sequence

mechanical properties. The mixtures containing peroxide-bleached CTMP exhibit somewhat lower light absorption and opacity, as a result of the higher yield loss.

Conclusions

An acceptable newsprint can be produced from a mixture of 60% bagasse chemical pulp and 40% eucalyptus CTMP. Both the bagasse chemical pulp and the eucalyptus CTMP can be produced with a low effluent load on the receiving waters.

A suitable bagasse chemical pulp can be produced by a soda cook to a kappa number of 20, followed by oxygen delignification to a kappa number of 10. The oxygen-delignified pulp can then be bleached with small amounts of hypochlorite or peroxide to the required brightness. The brightness of the bleached chemical bagasse pulp should not exceed the brightness target of the newsprint to be produced. To bleach the oxygen-delignified pulp with a kappa number of 10 to a brightness range of 55-60%, 1% hypochlorite or 1% peroxide will be required.

A suitable eucalyptus CTMP can be produced by cold soda method with about 1000 kW·h/a.d. metric ton, a relatively low consumption of electrical energy. The pulp can be bleached to a brightness of 55-60% ISO with 1-2% peroxide.

If peroxide bleaching is chosen for both the bagasse chemical pulp and the eucalyptus CTMP, then in principle the pulp production can be totally free from chlorine compounds. Theoretically, it should be possible to completely close the mill.

Experimental procedures

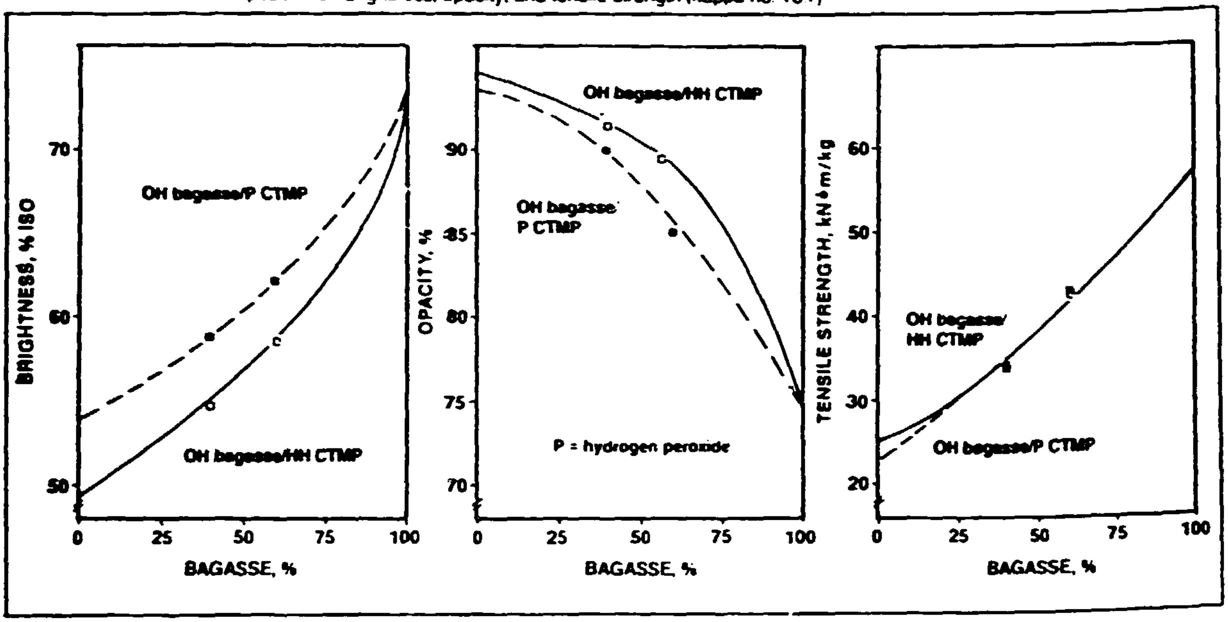
Bagasse

Raw bagasse from India was slushed in a pulper at 5% pulp consistency and 40°C for 30 min. Afterwards, it was thoroughly washed to remove sand and most of the pith. The yield after pretreatment and washing was 62.5%.

Soda pulping was performed in rotating 1-L stainless steel autoclaves at 165°C for 20 min. The bagasse liquor ratio was 1:4. After pulping, the bagasse was treated in a laboratory refiner. The gap between the refiner plates was 0.12-0.15 mm

Oxygen delignification was performed in the same equipment as for the soda pulping. Pulp consistency was 12%, the temperature was 105°C, the retention time was 90 min. Also, 0.5% $MgSO_4$ was added to the pulp. In a mill with an effective mixer, it should be possible to reduce the retention time by 50% or more and still obtain the same

8. The effect of furnish composition on brightness, opacity, and tensile strength (kappa no. 16.7)



results.

Bleaching was performed on well-washed pulps in sealed plastic bags. In the hypochlorite stages, pulp consistency was 12%, the temperature was 45°C, and the retention time was 90 min. In the peroxide stages, pulp consistency was 12%, the temperature was 80°C, and the retention time was 120 min.

Eucalyptus

Eucalyptus grandis chips from India were screened and impregnated with 5% NaOH and 2% Na_2SO_3 in pilot-scale tests, according to the continuous PREX method. After a 25-min retention time at 50°C, one stage of atmospheric refining was carried out in a type CD-300, conical, single-disc refiner. Before bleaching, the pulp was washed, and the pH was adjusted to 7.0.

Peroxide bleaching was carried out at 65°C for 120 min at 12% pulp consistency. As a chelating agent, 0.3% DTPA was used. No sodium silicate was used, because of environmental considerations.

Initially, an alkali optimization was carried out to determine the maximum brightness at charges of 0.7%, 1.4%, and 2.1% H_2O_2. A larger portion of pulp was bleached with about 2% peroxide at the optimum alkali charge to a brightness of almost 55% ISO. This pulp was used for evaluating pulp properties and for the mixing study with chemical bagasse pulp.

Hypochlorite bleaching was carried out at 45°C for 90 min at a pulp consistency of 12%. Both one-stage and two-stage bleaching were carried out. Two-thirds of the total charge of 6% NaClO, calculated as active chlorine, was added in the first stage, with the remaining third added in the second stage.

Analyses

The analysis methods are listed in Table VI. Mechanical properties were determined according to ISO procedures

VI. Methods of analysis

Property	*Test procedure*
Kappa number	SCAN C 1:77
Intrinsic viscosity	SCAN C 15—16:62
Brightness	SCAN C 11:75 (ISO)
COD	Swedish Standard SS 02 81 42
BOD	Swedish Standard SS 02 81 43
AOX	DIN 38409
Color	determined spectrophotometrically at pH 7 after an initial rapid stabilization at pH 10

AOX stands for adsorbable organically bound halogens on active carbon

Literature cited

1. Lowgren, U., Falk, B., and Ryrberg, G., paper presented at 1981 and 1982 ATCP meetings ATCP, Mexico City.
2. Lowgren, U., Falk, B., and Ryrberg, G., 1983 Annual Meeting Conference Proceedings, TAPPI PRESS, Atlanta, p. 37.
3. Nasman, L. and Annergren, G., Tappi 63(4): 105(1980).
4. Jackson, M., Falk, B., Moldenius, S., and Edstrom, A., 1987 International Mechanical Pulping Conference Proceedings, SPCI, Stockholm.

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PULP AND PAPERMAKING FROM BAGASSE

II RETROSPECTIVE SEARCH OF INFORMATION SOURCES FOR THE PERIOD 1980-1988 (*)

INDEX

note * (for information sources,see bibliography § 3)

2- ABSTRACTS: *

1.- Adaptation of Existing Recovery System for Handling Blend of Black Liquors from Bagasse and Wood - Experience of Seshasayee Paper and Boards [Ltd., India]
Mahadevan, N.; Sridhar, N. C.; Rao, P. N.; Kalyanasundaram, K.; Rao, A. R. K.
IPPTA 23, no. 4: 155-159 (Dec. 1986). [Engl.]
2 fig., 4 tab.
Document Type: JOURNAL ARTICLE
Languages: ENGLISH
A chemical recovery system designed specifically for bagasse black liquors encounters problems when it is forced to handle black liquors from a mixture of bagasse and wood. Parameters which pose problems in the recovery of chemicals from bagasse black liquor are high volume of weak black liquor, high viscosity of black liquor, difficulty getting required concentration, low swelling volume ratio of black liquor solids, and the high bed temp. required to sustain self-combustion. Problems encountered at Seshasayee Paper and Boards in handling bagasse liquor and the steps taken to overcome these problems are discussed. High steam cost incurred in evaporation and increased air pollution loads due to higher direct evaporation are areas which require attention by designers and technologists in order to arrive at economical solutions.

2.- Increased Understanding of Bagasse Pulping for Improved Chemical Recovery Efficiency and Better Environment
Kulkarni, A. G.; Mathur, R. M.; Naithani, S.; Pant, R.
IPPTA 23, no. 4: 95-100 (Dec. 1986). [Engl.]
10 ref., 7 tab.
Document Type: JOURNAL ARTICLE
Languages: ENGLISH
The effect of pulping variables on the black liquor properties and the pollution loads exerted was examined. Vapor phase pulping has advantages over conventional liquid phase pulping: it requires about 50% less steam, it produces about 50% less effluent, water consumption is reduced, pulp yield is increased without sacrificing the strength properties, and black liquors with more than double the concentration of liquid phase black liquors are produced. The effect of pith content, which is carried along with fibers in varying proportion on the black liquor properties, was also investigated. The pith has a sizeable influence over pulp and on black liquor properties. Due to the presence of pith in bagasse, colloidally unstable black liquor will be generated. To have colloidally stable black liquors, a residual alkali level of 6-8 g/L is desirable. Mill and laboratory black liquors showed colloidal unstability, a tendency of precipitate, and high viscosity which can be attributed to the presence of hmw lignins, hemicellulose fractions, and organic acids. Trials using a ferrite process developed for treatment of nonwoody raw materials gave encouraging results on pilot plant scale.

3.- Coloration of Bagasse. (1). Influence of Agro-Industrial Factors
Saavedra, F.; Hernandez, R.; Castillo, G.
Sobre Deriv. Cana Azucar (Rev. ICIDCA) 20, no. 1: 36-40 (Jan.-April 1986). [Span.; Engl. sum.]
10 ref., 3 tab.
Document Type: JOURNAL ARTICLE
Languages: SPANISH
The development of high-yield pulping processes and the introduction of new sources of fibrous raw materials in conventional pulping processes have resulted in great attention to the darkening of both the raw materials and the pulps produced from them. A study was conducted to determine the effect of agro-industrial factors such as cane variety, effect of heating cane, cutting method (i.e., manual or mechanized), and origin and storage of bagasse on the coloration of bagasse and the pulps made from it. Results show that the variety and origin of bagasse have little effect on pulp brightness. Harvesting (regardless of the method used) lowers brightness. The greatest losses in initial brightness (30%) result from heating the cane; storage has the second greatest negative effect on brightness. Suggestions are given for further studies to alleviate this problem.

4.- **107: 204453n Environment aspects in processing bagasse for pulp and paper manufacture.** Rao, N. J. (Inst. Pap. Technol., Saharanpur, 247001 India). *IPPTA* 1986, 23(4), 129-43 (Eng). The review with 49 refs. covers the environmental aspects of bagasse processing for pulp and paper prodn., including bagasse handling and storage, depithing, pulping, stock prepn. and paper making, pollution control strategies, pulp bleaching, and chem. recovery, and treatment methods.

see article p. 3

5.- **107: 200661f Bagasse-based paper mills - some Indian experiences and financial aspects.** Ramalinga, T. K. Setty (Banglore, India). *IPPTA* 1985, 22(3), 62-76 (Eng). A review with 6 refs. on the manuf. of pulp and paper from bagasse in Indian paper mills.

see article p. 18

6.- **Controlled Fermentation is the Key [to Bagasse Storage]**
Atchison, J.
Pulp Paper Int. 28, no. 11: 44-45 (Nov. 1986). [Engl.]
Document Type: JOURNAL ARTICLE
Languages: ENGLISH
Bagatex-20, a method of controlling fermentation in bagasse bales that will allow up to 2 yr of storage without fiber deterioration, has been developed by sugar and alcohol producer Usina Santa Lydia of Ribeirao Preto, Sao Paolo, Brazil. The depithed bagasse treated with Bagatex-20 (a biochemical catalyst) retains a brightness of 35-40 GL and is suitable for newsprint furnish.

see article p. 36

7.- **Preliminary Analysis of the Effect of the Percent of Pith and Caustic Soda on the Quality of Semichemical [Bagasse] Pulp**
Gonzalez Suarez, E.; Ulloa Diaz, S.; Ribot Enriquez, A.
Tecnol. Quim. 7, no. 4: 11-18 (1986). [Span.]
7 ref., 5 tab.
Document Type: JOURNAL ARTICLE
Languages: SPANISH
Experimental design was used to determine the effects of the amount of pith present, bagasse storage time, and amount of NaOH used on the yield and quality of semichemical pulp from bagasse. Process variables in developing the experimental design included cooking method, impregnation time, liquor/wood ratio, cooking liquor concentration, and amount of pith present. In this study, impregnation time was 10 min, with a 30 min cooking time at 160 C. The bagasse used was stored for different lengths of time; process variables were the amount of pith present, and amount of soda added to the bagasse. In general, pith adversely affects the yield and physical properties of pulps and increases steam and NaOH consumption during pulping. Increasing NaOH consumption favors physical pulp properties, but increases production costs and adversely affects other cost variables no less important than yields. In all cases, excess pith decreases fiber yields in bagasse pulp/fiber, and affects NaOH consumption. Bagasse storage time needs to be explored further because it makes pulp more sensitive to chemical changes, and adversely affects pulp properties. An optimum storage time can be determined for each type of paper produced. Equations are provided which can be used as models for predicting behavior trends of bagasse with different cooking methods. These results can be used as a base for production operating standards.

8.- **Modernization of a Paper Machine**
Ms, R.
ATCP 26, no. 3: 57-64 (May/June 1986). [Span.]
13 fig., 2 tab.
Document Type: JOURNAL ARTICLE
Languages: SPANISH
A description is given of a paper machine rebuild at the Fabrica de Papel San Juan, in Mexico. The machine produces bond paper from furnish consisting of a maximum of 60% bagasse and 40% bleached long kraft fibers. The project was aimed at increasing machine speed from 160 to 350 m/min, with the possibility of further increasing it to 450 m/min in the future. Other rebuild objectives were to increase the bagasse content of the pulp mixture to 90%, increase machine efficiency, improve sheet formation, decrease c m d. basis weight and moisture profile variations, and complete the project in a maximum of 100 days. Included in the rebuild is a Nipcombi type press with four rolls (viz., a suction pick-up roll, a central roll, and two Nipco rolls developed by Escher Wyss). This press and its operations are described in detail. The rebuild has achieved all objectives, and is an excellent example of coordinating work with high technology.

9.- 107: 178407d **Production of bagasse-based papers on high-speed machine and quality assurance.** Mehrotra, A. K.; Sarkar, P. K (SPB-PC, India). *IPPTA* 1986, 23(4), 89-94 (Eng). Bagasse, having short fibers, gives a relatively weak furnish which is difficult to run on conventional fourdrinier machines, even at moderate speeds. The selection of stock prepn. equipment and paper machine for the prodn. of bagasse-based papers for cultural and newsprint grades at high machine speeds and efficiency is discussed. For high-speed machines, extensive instrumentation for stock proportioning, consistency, and level control is a prerequisite.

see article p. 57

10.- 102: 168524x **Cuba-9's achievements in the technology for newsprint from bagasse.** Lopez, P.; Garcia, O. L.; Rodriguez, L. (Cuban Res. Inst. Sugar Cane By-Prod., Havana, Cuba). *Nonwood Plant Fiber Pulping* 1985, 15, 13-17 (Eng). Furnish from chemimech. bagasse pulp 80, groundwood pulp 10, and semibleached kraft pulp 10% was formed into sheet on a machine at 550-600 m/min, giving paper with basis wt. 52 g/cm², d. 500-640 kg/m³, tensile strength 20.4 Nm/kg, and tear factor 4.0 in the machine direction. Runnability of furnish in the paper and printing machine was good, efficiency in the paper machine was 80-85%, and there was no problem of breaks or linting in the printing press. Chemimech. and mech. pulping characteristics of bagasse, brightening of bagasse pulp with H_2O_2 and dithionite, physicomech. properties of bagasse pulp, and storage of bagasse are discussed.

11.- 102: 168505c **Pilot plant experiences by GIRIS-HZ bagasse pulping process.** Nojima, S.; Umeda, K.; Sato, T.; Yoshinaga, M.; Kobayashi, Y. (Project Eng. Cent., Hitachi Zosen Corp., Osaka, Japan). *Nonwood Plant Fiber Pulping* 1985, 15, 113-21 (Eng). Pilot plant trials showed that the GIRIS-HZ process, based on chemithermomech. pulping of bagasse, affords high yield (80-90%) pulp with remarkable strength properties, low refining energy consumption (1000-1300 k Wh/ton pulp), pulp brightness of 50-60% and low chem. charge (NaOH and Na_2SO_3). Papermaking trials indicated that paper has good printability and suitability for use as the main component of newsprint grade; pulp produced by this process is also suitable for corrugated medium by the alternation of chem. pretreatment conditions.

see article p. 38

12.- 102: 168504r **Pulping of bagasse and non-wood fibers in Taiwan.** Ying, T. P. (Taipei, Taiwan). *Nonwood Plant Fiber Pulping* 1985, 15, 103-11 (Eng). Kraft, soda, and sulfite pulping characteristics of bagasse, reed, bamboo, rice straw and kenaf are discussed.

13.- Energy Economy Measures at Mysore Paper Mills Ltd., Bhadravati, Karnataka [India]
Nair, V. S. K.
IPPTA Convention Issue 1985: 94-96 (1985). [Engl.]
Document Type: JOURNAL ARTICLE
Languages: ENGLISH
Steps taken at Mysore Paper Mills for heat/energy conservation include insulation of the steam lines, digesters, evaporator bodies, and continuous causticizers; use of a blow-heat recovery system in the digesters; use of evaporator cooling water for countercurrent brown stock washing; and recovery of all condensate water from the evaporators, paper machines, and turbines for boiler feed. Water consumption in the newsprint mill has been reduced by making maximum use of back water, controlling overflows by providing suitable control devices, and minimizing valve leakage. In its expansion for newsprint and integration of a sugar mill, Mysore made use of the power cogeneration concept. In this way, the sugar mill bagasse which had formerly been burned for power and steam was made available for use in papermaking.

14.- Approach to Minimize Pollution Problems through Vapor-Phase Pulping Process
Mathur, R. M.; Bist, V.; Naithani, S.; Kulkarni, A. G.; Pant, R.
IPPTA Convention Issue: 115-122 (March 1984). [Engl.]
1 fig., 8 ref., 7 tab.
Document Type: JOURNAL ARTICLE
Languages: ENGLISH
In an attempt to reduce the amount of effluents discharged from liquid-phase pulping, straw and bagasse were pulped via the vapor-phase process. This process involved presoaking the raw materials in 25-35 g/L NaOH solution with 1:3.5 material/liquor ratio, followed by cooking at 160 C. No black liquor was generated, and less water was required for pulp washing. The quantity of effluent and the organic load in the pulping effluents were reduced significantly. The properties of vapor-phase pulps were comparable to those of conventional liquid-phase pulp. Bagasse pulps produced by using the vapor-phase process had better strength properties than the liquid-phase pulps. Pilot-plant trials indicated that adoption of the vapor-phase process would reduce pollution load and steam consumption.

15.- 100: 176710d **The effect of milling on the papermaking properties of several Australian sugarcane varieties.** Gartside, G.; Langfors, N. G.; Miller, K. (Div. Chem. Wood Technol., CSIRO, Clayton 3168 Australia). *Nonwood Plant Fiber Pulping* 1983, 14, 37-44 (Eng). For 6 varieties of sugarcane, there are significant decreases in papermaking properties due to the sugar milling processes. Soda pulps prepd. from bagasse had lower strength properties than those prepd. from sugarcane, e.g., at 250 Canadian Std. freeness, the tear index was reduced by ~30%, and the burst index and breaking length were decreased by ~15%. There was no significant change in fiber length during the cane milling, the reduced pulp strength was due to fiber damage as indicated by kinks and folds in the fiber walls. Of the sugarcane varieties, Q80 and Triton yielded bagasse having the highest pulp strengths.

16.- 100: 165366L **Manufacture of corrugating medium paper utilizing 100% bagasse furnish.** Rangan, S. G. (Sehsaseyee Paper and Boards Ltd., Erode, 638007 India). *IPPTA* 1983, 20(1), 18-20 (Eng). Soda cooking of bagasse for 30-60 min at 60-80 psi pressure gave pulp in 55% yield for use in manuf. of corrugating medium paper. see article p. 47

17.- 100: 165365j **Modified pulping process for newsprint-grade pulps from bagasse.** Sharma, Y. K.; Bhola, P. P.; Singh, S. P. (Cell. Paper Branch, For. Res. Inst. and Coll., Dehra Dun, India). *IPPTA* 1983, 20(1), 1-5 (Eng). Cooking of whole bagasse with 4.8-6.4% NaOH for 30 min at ~95° gave pulp in 80-85% yield, having tensile index 17-36 N-mg, tear index 2-4 mN-m²/g, burst index 0.1-1.5 kPa-m²/g, ISO brightness ~40, and opacity 92-94% suitable for newsprint paper. Mixing of 30% NaOH-treated long fibers with untreated short fibers gave sufficiently strong sheet for use in the prepn. of newsprint. Bleaching of bagasse soda pulp, short fibers or fiber blends by H or HP sequence gave products having 61-67 ISO brightness. The addn. of 20% bleached bamboo pulp improved strength properties and brightness of whole bagasse pulp.

18.- 100: 36015f **Pulping of Egyptian bagasse with reduced environmental pollution.** Abou-State, M. Amine; Abd-Elmegeid, Fouad F.; El-Masry, Ahmed M. (Fac. Sci., Univ. Cairo, Giza, Egypt). *Pap., Carton Cellul.* 1983, 32(10), 65-7 (Fr). To reduce environmental pollution, Egyptian bagasse (from which pith was removed) was delignified in closed digesters contg. only NaOH solns. Pulp yields and properties were optimim in cooking 3 h at 120° with 13% NaOH (liquor-bagasse ratio 10:1). The yield before bleaching was 57.5% and lignin content 2.5%.

19.- How to Improve Quality of Sugarcane Bagasse for Papermaking
Gartside, G.
CSIRO Inst. Ind. Technol. Res. Rev.: 23-28 (1983). [Engl.]
2 fig., 3 tab.
Document Type: JOURNAL ARTICLE
Languages: ENGLISH

It has been shown for several sugarcane varieties that current methods of rapid sugar extraction damage the fiber. Hence the residual bagasse is less valuable for papermaking than the original cane. Ways of obtaining superior bagasse are described, incl. selecting the larger bagasse pieces, eliminating the final dewatering of paper-grade bagasse, selecting better varieties, and trying novel processing methods, such as EtOH extraction, mechanical pulping for newsprint production, and particularly the Tilby process, in which the sugar-poor outer rind is separated from the pithy core of the stalk to yield fiberboards that resemble particle boards.

20.- **98: 36363b Bagasse pulp.** Agency of Industrial Sciences and Technology **Jpn. Kokai Tokkyo Koho JP 57,133,290 [82,133,290]** (Cl. D21C3/22), 17 Aug 1982, Appl. 81/19,342, 10 Feb 1981; 3 pp. In the pulping of bagasse with aq. KOH and optionally H_2O_2, molasses is burned to supply energy and alkali. Thus, 10 kg molasses contg. 80% solids was burned, and thermal energy and ash were recovered. The ash was extd. with water to give 3 L aq. soln. contg. 69.8 g/L K_2CO_3 and causticized with CaO to give aq. KOH, and 0.4 kg bagasse was treated with the aq. KOH at liquor ratio 10 L/kg, K_2O 30.3%, and 165° for 60 min to prep. 36.2% pulp.

21.- **97: 164832b Producing newsprint.** Villavicencio, Eduardo J. (Grace, W. R., and Co.) **U.S. US 4,347,101** (Cl. 162-25; D21C1/02), 31 Aug 1982, Appl. 210,057, 24 Nov 1980; 9 pp. In the title process, bagasse or wood chips are cooked on a 1st prodn. line with NaOH, $NaOH-Na_2SO_3$ or $-NaHSO_3$, and kraft liquor for 0.1-1 h at 140-190°, refined at >100° and bleached with peroxide or OCl^- to give thermochem. pulp (TCP); and in a 2nd line, the same cellulosic materials are steamed at >2 kg/cm², refined, and bleached to give thermomech. pulp (TMP), the combined pulp having 55-60 GE brightness and 93-96% opacity.

22.- Improvement of Causticizing System in a Bleached Bagasse Pulp Plant see article p.63
Wang, J. S. I.
TAPPI Pulping Conf. (Toronto) Proc.: 261-266 (Oct. 25-27, 1982). [Engl.]
4 fig., 3 tab.
Document Type: CONFERENCE LITERATURE
Languages: ENGLISH

Steps taken to correct problems with scale formation in evaporators, incomplete burning of black liquor, low efficiency causticizing, and poor quick lime quality at the Ping-Tung Bagasse Pulp Factory, Taiwan, are discussed. Among the new causticizing conditions implemented, reaction time was increased from 108 to 150 minutes, which increased overall causticizing efficiency by 10%. The reaction temperature was set at 103 (+ or -)1 C and the green liquor temperature at 92-94 C. In order to stabilize the purity of calcined quick lime, the lime mud discharging rate was increased from 20 to 30%. The size of limestone used for makeup was reduced and the lime mud moisture was lowered to approx. 15% to achieve an increase in calcining efficiency of 10%.

23.- **97: 57350w Pulping equipment for agricultural residues - some important design factors.** Trivedi, M. K. (Chem. Eng. Dep., Indian Inst. Technol., Bombay, 400 076 India). *IPPTA* **1981**, 18(2), 1-4 (Eng). Bagasse, cotton stalk, and straw from rice, wheat, and corn as agricultural wastes have less complex structure than wood and are easily cooked with 20-30 % NaOH at ~100° to give pulp in 52-60 % yield. The design of pulping equipment for agricultural wastes should be simple and versatile to process the raw materials in accordance with their seasonal availability.

24.- **96: 164430y An evaluation of the damage to sugar cane fiber during milling.** Gartside, Geoffrey; Langfors, N. Goran; Miller, Ken (Div. Chem. Technol., CSIRO, South Melbourne, Australia). *Holzforschung* 1982, 36(1), 23-8 (Eng). The soda pulping of bagasse sampled from various parts of a sugarcane mill revealed that there is a substantial redn. in the papermaking properties of bagasse fibers resulting from the milling of sugarcane. Major redns. occurred during hammer milling of cane prior to sugar extn. and in the final drying roller of bagasse formed, where there are the highest fiber compaction and load. Since there is little redn. in fiber length, the quality redn. seems to be due to damage to the fiber walls.

25.- **96: 8432v Paper pulp from compressible cellulosic materials for paper, cardboard or other similar cellulosic products.** Vercruysse, Edgar L. M. Belg. BE 887,760 (Cl. D21C), 03 Sep 1981, Appl. 2,039, 03 Mar 1981; 21 pp. The title pulp is prepd. from bagasse, straw, etc. by steeping the cellulosic material in a liquor at >1 atm and treating it in a screw press to sep. the fibers by vapor-phase cooking. Thus, newsprint pulp was prepd. from bagasse (fiber content 80-82%) by drying 8 min at 100°, steeping in aq. NaOH (43 g/L) 15 min at 60° and 7.7 kg/cm^2, treating with a screw press to liq.-solid ratio 2:1, and cooking at 168° and 7.7 kg/cm^2. Steeping at 1 atm required 45 min at 70°.

26.- **95: 205687n Bagasse chemithermomechanical pulps and their utilization for newsprint.** Fuentes, Ernesto F. (Springfield, OH 45501 USA). *Pulping Conf., [Proc.]* 1981, 233-40 (Eng). Thermomech. treatment of bagasse in disk refiner in the presence of $NaOH-H_2O_2$ or $-Na_2SO_3$ mixt. gave chemithermomech. pulp (CTMP), with Elrepho brightness 39-41%, opacity 92-6%, shive content 2-5%, and improved mech. properties. A furnish of 85% bagasse CTMP and 15% kraft pulp produced newsprint sheet, physicomech. properties of which were comparable to those of conventional newsprint.

27.- **95: 205683h Experiences of bagasse pulping with rapid continuous digester.** Krishnamachari, K. S.; Rangan, S. G.; Ravindranathan, N. (Seshasayee Pap. Boards Ltd., Erode, 638 007 India). *Pulping Conf., [Proc.]* 1981, 61-7 (Eng). The continuous cooking of depithed bagasse in the presence of 12-4% NaOH for 10-12 min at 80-100 psi pressure gave pulp in 42-4% yield, with permanganate no. 9-11, burst factor 43-6, breaking length 5757-6583 m, tear factor 48-9, and double fold 195-282. Bleaching by CEHH sequence produced pulp with 75-8% brightness.

28.- **95: 82644m Thermomechanical and chemithermomechanical pulping of bagasse for newsprint grade.** Nishiyama, Masashi; Matsuo, Ryukichi; Kobayashi, Yoshinari; Sato, Tadashi; Niyomwan, Naiyana (Gov. Ind. Res. Inst., Takamatsu, Japan 761). *Cellul. Chem. Technol.* 1981, 15(2), 227-36 (Eng). Thermomech. pulping of bagasse at steam pressure 2 kg/cm^2 gave a product in 90-6% yield, with improved strength properties and a low fines content. The addn. of 20-30% softwood kraft pulp to bagasse thermomech. pulp gave paper, the physicomech. properties of which was comparable to those of com. newsprint. In the chemithermomech. pulping, the use of NaOH improved the strength properties but decreased the brightness of resulting pulp. The addn. of Na_2SO_3 and NaOH improved the strength properties and optical properties and reduced the energy consumption in refining of bagasse chemithermomech. pulp (CTMP). The sheet properties reached to comparable level of conventional newsprint, when bagasse CTMP was mixed with 15% softwood kraft pulp.

29.- **95: 26873y Paper pulp from sugar mill bagasse.** Krueger, Horst; Berndt, Wilhelm; Schwartzkopff, Ursula; Reitter, Franz J.; Hoepner, Theodor; Muehlig, Hans Joachim U.S. 4,260,452 (Cl. 162-23; D21C1/00), 07 Apr 1981, Appl. 685,326, 11 May 1976; 8 pp. Cont.-in-part of U.S. Ser. No. 884,513, abandoned. Neutral sulfite semichem. (NSSC) cooking of depithed bagasse gave pulp with improved physicomech. properties for use in the prodn. of newsprint paper. Thus, the NSSC cooking at 170-75° gave pulp in 70-5% yield. The NSSC pulp as above was bleached with alk. H_2O_2 at 50-70° to give a product with breaking load 8.7 kg, tensile 3.9%, breaking length 7.13 km, abs. tearing strength 135 cmg/cm, abs. bursting strength 3.8 kg/cm², and Elrepho brightness 61.

30.- **94: 158634k Apparatus and method for cooking wood fibers to make pulp.** Sherman, Michael Ignacy; Richter, Johan C. F. C. (Kamyr, Inc.) Ger. Offen. 3,027,847 (Cl. D21C7/00), 26 Feb 1981, US Appl. 62,189, 30 Jul 1979; 28 pp. The 2-stage digester unit continuously impregnates wood chips, straw, and bagasse with cooking liquor and then cooks it at 168-70°.

31.- **Review of High-Yield Pulping and Manufacture of Newsprint from Bagasse**

Qureshi, O. A.

PIRA Rept. PB/S(R)/1980: 52 p. (1981). [Avail. from PIRA as PM 7757]

Document Type: JOURNAL ARTICLE; REVIEW

Languages: ENGLISH

The use of bagasse as a source of papermaking fibers, its storage, and depithing are summarized. Processes (25) for newsprint production from bagasse are reviewed, incl. chemical, chemimechanical, mechanical, and thermomechanical pulping processes. Minimum strength and optical properties desirable in bagasse newsprint are outlined. From: PIRA Paper & Board Abstr. 15, no. 13: abstr. 257 (March 1982).

32.- **94: 32576z Preservation and storage of bagasse.** Cusi, D. S. (Procesos Tec. Ind. S.A., Mexico City, Mex.). *Sugar Azucar* 1980, 75(9), 127, 130-2, 135-6, 138, 140 (Span). Measures are discussed for control of biodegrdn. of bagasse during storage in piles. The bagasse accumulates during the sugar cane harvest season and is used gradually during the rest of the year for pulping to make paper products. The first reaction to occur is consumption of residual sugars by mesophilic yeasts, and stimulation of this reaction can reduce subsequent degrdn. of cellulose by other organisms. Temp. profiles in bagasse storage piles are given.

33.- **FURTHER INVESTIGATION ON CHEMITHERMOMECHANICAL PULPING OF BAGASSE AND HYDROGEN PEROXIDE BLEACHING OF THE PULPS THEREFROM**

Kobayashi, Y.; Nishiyama, M.; Matsuo, R.

TAPPI Pulping Conf. (Atlanta) Proc.: 249-260 (Nov. 16-19, 1980).

23 fig., 18 ref., 2 tab.

Document Type: CONFERENCE LITFRATURE

Languages: ENGLISH

The manufacture of newsprint-grade CTMP from three kinds of bagasse (cultivated in Japan and India) was examined. A laboratory-scale pressurized refiner was used. The effects of chemical pretreatment and types of disk plate patterns on sheet strength and energy consumption were studied. Alkaline sodium sulfite, having a synergistic effect, improved paper strength, with a slight decrease in brightness, and also reduced power consumption. The pure bagasse CTMP sheets satisfied the commercial Japanese specifications for strength and brightness when bleached with hydrogen peroxide. Plate patterns also influenced energy requirements. The effects of conventional multistage and refiner hydrogen peroxide bleaching were compared; in the latter process, brightness improvement was limited. It was concluded that the CTMP process, aided by synergistic effects of alkaline sodium sulfite, had excellent potential for mechanically producing newsprint-grade pulp from bagasse.

**

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5.- 104: 151080t **Pulp and paper from Egyptian bagasse by alkaline sulfide-sulfite pulping.** Abou-State, M. Amine; Abd El-Megeid, Fouad F.; El-Masry, Ahmed M. (Fac. Sci., Univ. Cairo, Giza, Egypt). *Holzforschung* 1985, 39(6), 361-4 (Eng).

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79.- 94: 32480p **Review of the progress in the utilization of bagasse for the manufacture of corrugating medium in South Africa.** Botes, Ernest (Hultech (Pty) Ltd., Durban, S. Afr.). *Pulping Conf., [Proc.]* **1980**, 269-76 (Eng).

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81.- 93: 222067m **Manufacture of nonwood pulp.** Mita, Akio (Tokyo Univ. Agric., Tokyo, Japan). *Gendai Kagaku* **1980**, 114, 50-7 (Japan). A review with no refs.

82.- 93: 97187x **Manufacture of bagasse pulp.** Agency of Industrial Sciences and Technology **Jpn. Kokai Tokkyo Koho** 80 57,091 (Cl. D21C3/06), 28 Apr 1980, Appl. 78/125,769 13 Oct 1978; 3 pp.

83.- 93: 97183t **Manufacture of pulp.** Onda, Akio; Kashiwara, Susumu; Saeki, Takeshi; Yazawa, Yoshinori (Agency of Industrial Sciences and Technology) **Jpn. Kokai Tokkyo Koho** 80 51,890 (Cl. D21C3/06), 15 Apr 1980, Appl. 78/125,768, 13 Oct 1978; 3 pp.

84.- **93: 28032a Paper pulp from nonwooden fiber materials.** Kobayashi, Yoshinari; Matsuo, Ryukichi; Nishiyama, Masashi; Nojima, Satoshi; Sato, Takashi (Agency of Industrial Sciences and Technology; Japan, Ministry of International Trade and Industry; Hitachi Shipbuilding and Engineering Co., Ltd.) Ger. Offen. 2,941,965 (Cl. D21C5/00), 30 Apr 1980, Japan. Appl. 78/131,837, 25 Oct 1978; 19 pp.

85.- **92: 182754d The sulfate delignification of bagasse. 2. The effect of sulfidity on physical properties of pulps.** Gonzales, R. B.; Kosik, M.; Brabec, J.; Farkas, J. (Inst. Cubano Invest. Deriv. Cana Azucar, Havana, Cuba). *Cellul. Chem. Technol.* 1980, 14(1), 75-9 (Eng).

86.- Future of Nonwoody Fiber Usage in Papermaking
Judt, M.
UNEP Ind. Envir. 3, no. 4: 12-14 (Oct.-Dec. 1980).
4 tab.

87.- NEW LOW-COST FREE-STANDING BLEACH PLANT SUGGESTED FOR MILD CLIMATES
Perkins, J. K
Pulp Paper 54, no. 5 96-97 (May 1980).

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4- UNIDO PAPERS ABSTRACTS:

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DOCUMENT DATE: 1988
CALL NUMBER:
PERSONAL AUTHOR: Rivera de Castillo, Altagracia
CORP. AUTHOR: UNIDO
CONFERENCE: INTERREGIONAL CONSULTATION ON THE FOOD-PROCESSING INDUSTRY WITH EMPHASIS ON SUGAR-CANE PROCESSING, 1ST, HAVANA, 1988
TITLE: DIVERSIFICACION DE LA INDUSTRIA DE LA CANA DE AZUCAR. DOCUMENTO DE BASE PARA EL PUNTO I. - THE DIVERSIFICATION OF THE SUGAR-CANE INDUSTRY. BACKGROUND PAPER FOR ISSUE I.
SOURCE: Vienna, 1988. i, 41 p. tables, diagrams.
DOC. NUMBER: UNIDO-ID/WG.476/2
ABSTRACT: <UNIDO pub> on <food> <processing> industry with special emphasis on <diversification> of <sugar cane> industry - covers (1) the <cane sugar> industry: present situation (<market>, <prices>, <import>s; sugar substitute sweeteners) (2) prospects: <by-product> utilization (3) diversification of <sugar industry>: strategies for reorientation; total use of sugar cane (animal <feed>, <alcohol>, <pharmaceuticals>; alco-<chemical industry>) (4) by-products of industrial processing of sugar cane: <bagasse> and derivatives (<pulp>, <paper>); <molasses> (<yeast>; <citric acid>) (5) <financial aspects>; <management>; <international cooperation>. <Bibliography>, <diagram>s, <statistics>.
LANGUAGES: SPAN ENGL
CLASSIFICATION: 31.30

RECORD NUMBER: 016939
DOCUMENT DATE: 1988
CALL NUMBER:
PERSONAL AUTHOR: Wells, Jeremy
CORP. AUTHOR: UNIDO
CONFERENCE: INTERREGIONAL CONSULTATION ON THE FOOD-PROCESSING INDUSTRY WITH EMPHASIS ON SUGAR-CANE PROCESSING, 1ST, HAVANA, 1988
TITLE: STUDY ON THE MARKET ASPECTS OF BY-PRODUCTS: DIVERSIFICATION OF THE SUGAR INDUSTRY.
SOURCE: Vienna, 1988. i, 29 p. tables.
DOC. NUMBER: UNIDO-ID/WG.476/1
ABSTRACT: <UNIDO pub> on <market> aspects of <by-product>s with special reference to <diversification> of the <sugar industry> - covers (1) major by-products and their market potential: <pulp> and <paper> from <bagasse>; <forecast>; <furfural> and derivatives; relevant foreign <trade>; <ethanol> and <chemicals> from <alcohol>; <citric acid> etc. (2) <tariffs> and non-tariff <trade barriers> (3) programme development for diversifying sugar industry; improvement of existing products; alternative <agricultural products>; utilization of bagasse as <fuel>; <molasses>. <Bibliography>, <statistics>. Additional references: <export>, <import>, <North-South> and <South-South> <cooperation>, <wood>, <newsprint>.
LANGUAGES: ENGL
CLASSIFICATION: 31.30

RECORD NUMBER: 016570
DOCUMENT DATE: 1987
CALL NUMBER:
PERSONAL AUTHOR: Silverio, Herly Noa
CORP. AUTHOR: UNIDO
CONFERENCE: EXPERT GROUP MEETING FOR THE LATIN AMERICAN AND CARIBBEAN REGION, IN PREPARATION OF THE 1ST CONSULTATION ON THE SUGAR-CANE PROCESSING INDUSTRY, VIENNA, 1987 -
TITLE: LA DIVERSIFICACION DE LA AGROINDUSTRIA AZUCARERA EN AMERICA LATINA Y EL CARIBE.
- THE DIVERSIFICATION OF THE CANE SUGAR INDUSTRY IN LATIN AMERICA AND THE CARIBBEAN.
SOURCE: Vienna, 1987. 15 p. tables, diagrams.
DOC. NUMBER: UNIDO-ID/WG.471/1
ABSTRACT: <UNIDO pub> on <diversification> of <cane sugar> industry in <Latin America> and the <Caribbean> - covers (1) <by-product>s and derivatives of <sugar cane>, such as <molasses>, <bagasse>, <citric acid>, <dextran>, <fertilizer>s, <fibreboard>, <furfural>, <paper>, <pesticides>, <resins>, <pharmaceuticals>, <wax>, and torula <yeast> (2) analysis of the regional <sugar industry> (3) utilization of the by-products mentioned; (a) use of <alcohcl> for <fuel> and alco-<chemistry> (b) <feed production> (c) use of bagasse for <energy> generation and <pulp and paper industry>. <Recommendations>, <statistics>, illustrations, <bibliography>. Additional reference: <fibre plants>.
LANGUAGES: SPAN ENGL
COUNTRY CODE: 910, 899
CLASSIFICATION: 31.10

RECORD NUMBER: 015652
DOCUMENT DATE: 1985
CALL NUMBER:
PERSONAL AUTHOR: Jeyasingam, T.
CORP. AUTHOR: UNIDO
TITLE: KENYA. ASSISTANCE TO THE MINISTRY OF INDUSTRY. DEVELOPMENT OF THE PULP AND PAPER INDUSTRY IN KENYA. TECHNICAL REPORT. PART II: REPORT ON THE FEASIBILITY OF PRODUCING FINE PAPER FROM BAGGASE IN KENYA.
PROJ. NUMBER: DP/KEN/80/001
SOURCE: Vienna, 1985. 44 p. tables.
DOC. NUMBER: UNIDO-DP/ID/SER.A/629
UNIDO-DP/ID/SER.A/629/Add.1
ABSTRACT: <UNIDO pub>. <Expert report> on the development of the <pulp and paper industry> in <Kenya> with special reference to feasibility of producing fine <paper> from <bagasse> - covers (1) <site assessment>; <production capacity>; bagasse supply; <fuel> replacement bagasse (2) <natural fibres>: planting of high fibre content <sugar cane> (3) <location of industry>; <water supply>, <electric power> supply (4) <staff>, <training>, <transport> (5) the mill processing system: <pulp>ing, washing and screening; <bleaching>; <machinery>. Appends i.a. <capital.costs> and <working capital> estimates. <Recommendations>, <statistics>.
LANGUAGES: ENGL
COUNTRY CODE: 240
CLASSIFICATION: 32.10

RECORD NUMBER:	015651
DOCUMENT DATE:	1985
CALL NUMBER:	
PERSONAL AUTHOR:	Jeyasingam, T.
CORP. AUTHOR:	UNIDO
TITLE:	KENYA. DEVELOPMENT OF THE PULP AND PAPER INDUSTRY. TECHNICAL REPORT. PART I: SUMMARY.
PROJ. NUMBER:	DP/KEN/80/001
SOURCE:	Vienna, 1985. 63 p. tables, diagrams.
DOC. NUMBER:	UNIDO-DP/ID/SER.A/629
ABSTRACT:	<UNIDO pub>. <Expert report> on development of the <pulp and paper industry> in <Kenya> - covers (1) present state of the industry; <production capacity> (2) <market>; <domestic production>; <import>ed <paper>; <demand> <forecast> (3) <raw material>s: <wood>, <bamboo>, papyrus, <cotton> sticks, <coffee> sticks, <bagasse> from <sugar cane>, <wood wastes>, <waste paper>, <straw> (4) non-fibrous resources: <water supply>, <steam> supply, <power supply> (5) <effluent treatment>; <training>; <transport>. <Recommendations>, <bibliography>, <maps>, <statistics>.
LANGUAGES:	ENGL
COUNTRY CODE:	240
CLASSIFICATION:	32.10

RECORD NUMBER:	011366
DOCUMENT DATE:	1981
CALL NUMBER:	
PERSONAL AUTHOR:	DAVIS HB
CORP. AUTHOR:	UNIDO GUYANA, NATIONAL SCIENCE RESEARCH COUNCIL
CONFERENCE:	NATIONAL SEMINAR ON TECHNOLOGY TRANSFER MANAGEMENT AND INDUSTRIAL DEVELOPMENT, GEORGETOWN, GUYANA, 1981
TITLE:	THE SUGAR INDUSTRY.
SOURCE:	(in "Technology transfer problems and developments in Guyana". Vienna, 1981. pp. 109-116).
DOC. NUMBER:	UNIDO-UNIDO/IS.302
ABSTRACT:	<UNIDO pub> on <technology transfer> in the <sugar industry>, based on experience in <Guyana> - covers (1) <agricultural mechanization>; <management> of early transfer of technology; implementation of further field mechanization; change in organizational and management structure; spin-off effect of field mechanization (2) management of ridge and furrow trials; policy of logical transfer (3) forward <planning>: a technology transfer <factory>; management pitfalls; potential for transfer of advanced <skills> and <knowhow> in factories (4) <paper> manufacture from <bagasse>; <machinery> conservation; <spare parts> production; <electronic data processing>. Additional reference: <sugar cane>.
LANGUAGES:	ENGL
COUNTRY CODE:	180
CLASSIFICATION:	31.30

RECORD NUMBER: 010913
DOCUMENT DATE: 1980
CALL NUMBER:
PERSONAL AUTHOR: LEHTINEN A
CORP. AUTHOR: UNIDO
CONFERENCE: INTERNATIONAL EXPERTS GROUP MEETING ON PULP AND PAPER TECHNOLOGY, MANILA, 1980
TITLE: USE OF BAGASSE AND OTHER UNCONVENTIONAL RAW MATERIALS IN MODERN PAPER MAKING AND EXPERIENCE OF THE NEW FORMERS FOR ABOVE.
SOURCE: Vienna, 1981. 21 p. tables, graphs, illus.
DOC. NUMBER: UNIDO-ID/WG.352/25
ABSTRACT: <UNIDO pub> on forming <machinery> for use with <bagasse> and other unconventional raw materials in the <pulp and paper industry> - covers (1) the evolution of forming devices (2) <engineering design> for <paper> machine wet end; Sym-nozzle headbox, Sym-former, speed-former, Sym-presses; technological advantages; choice of process (3) trial runs with fibres from some unconventional <fibre plants>. Additional references: eucalyptus, <newsprint>, <waste paper>, <innovation>.
LANGUAGES: ENGL
CLASSIFICATION: 32.10

RECORD NUMBER: 010908
DOCUMENT DATE: 1980
CALL NUMBER:
PERSONAL AUTHOR: NIYOMWAN N
CORP. AUTHOR: UNIDO
CONFERENCE: INTERNATIONAL EXPERTS GROUP MEETING ON PULP AND PAPER TECHNOLOGY, MANILA, 1980
TITLE: THE PULP AND PAPER SITUATION IN THAILAND.
SOURCE: Vienna, 1981. 5 p.
DOC. NUMBER: UNIDO-ID/WG.352/28
ABSTRACT: <UNIDO pub> on the <pulp and paper industry> in <Thailand> - covers (1) status of existing <paper> industry (2) <raw material>s for <pulp>: <rice> <straw>, Burma <grasses>, <bagasse>, <bamboo>, <kenaf>, <rubber> <wood>; <tree species> (3) a kenaf pulp mill project; <research>.
LANGUAGES: ENGL
COUNTRY CODE: 420
CLASSIFICATION: 32.10

RECORD NUMBER: 010806
DOCUMENT DATE: 1980
CALL NUMBER:
PERSONAL AUTHOR: LEHTINEN A
CORP. AUTHOR: UNIDO
CONFERENCE: INTERNATIONAL EXPERTS GROUP MEETING ON PULP AND PAPER TECHNOLOGY, MANILA, 1980
TITLE: BAGASSE NEWSPRINT WITH VALMET SYM-CONCEPT.
SOURCE: Vienna, 1981. 10 p. graph, illus.
DOC. NUMBER: UNIDO-ID/WG.352/25
ABSTRACT: <UNIDO pub> on <machinery> for production of <newsprint> from <bagasse> <pulp> in <Peru> - covers: background; <research programmes> for most suitable designs of bagasse <paper> machinery; operating data; results; operating experience at Paramonga mill. Graph, illustrations.
LANGUAGES: ENGL
COUNTRY CODE: 339
CLASSIFICATION: 32.10

RECORD NUMBER: 010875
DOCUMENT DATE: 1980
CALL NUMBER:
PERSONAL AUTHOR: AGUERO TORRES C
CORP. AUTHOR: UNIDO
CONFERENCE: INTERNATIONAL EXPERTS GROUP MEETING ON PULP AND PAPER TECHNOLOGY, MANILA, 1980
TITLE: CUBAN EXPERIENCES IN NEWSPRINT FROM BAGASSE.
SOURCE: Vienna, 1981. 10 p. tables.
DOC. NUMBER: UNIDO-ID/WG.352/10
ABSTRACT: <UNIDO pub> on the <pulp and paper industry> in <Cuba>, with special reference to <newsprint> manufacture from <bagasse> - covers (1) <raw material> (2) processing to produce <pulp> (3) brightening of mechanical types of pulp from bagasse (4) features of a <pilot plant> (5) bagasse <storage> and preparation area (6) pulping and <bleaching> stations; stock preparation; <paper> <machinery>; <drying> machine; service and <utilities>. <Statistics>. Additional reference: <chemicals>.
LANGUAGES: ENGL
COUNTRY CODE: 105
CLASSIFICATION: 32.10

RECORD NUMBER: 010873
DOCUMENT DATE: 1980
CALL NUMBER:
PERSONAL AUTHOR: MOEHJI RN
CORP. AUTHOR: UNIDO
CONFERENCE: INTERNATIONAL EXPERTS GROUP MEETING ON PULP AND PAPER TECHNOLOGY, MANILA, 1980
TITLE: THE PAPER AND BOARD MILL SITUATION IN INDONESIA.
SOURCE: Vienna, 1981. 7 p. tables.
DOC. NUMBER: UNIDO-ID/WG.352/5
ABSTRACT: <UNIDO pub> on the <pulp and paper industry> in <Indonesia> - covers (1) <raw material>s (<wood>, <bamboo>, <bagasse>, <rice> <straw>) (2) <processing>: <pulp> production; <import> of pulp and <waste paper> (3) <paper> <machinery> (4) <utilities>; <manpower> (5) <production targets> and <domestic consumption> of paper and <cardboard>; <demand>. <Statistics>.
LANGUAGES: ENGL
COUNTRY CODE: 207
CLASSIFICATION: 32.10

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THIRD EDITION

VOLUME 3

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FROM BAGASSE AND WHEAT-STRAW

by QAMAR AHMED QURESHI,
GOVERNMENT INDUSTRIAL RESEARCH LABORATORY
BANK ROAD, LAHORE, PAKISTAN.

NOVEMBER, 1980

QAQ/MG.

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V. PULP MILLS

1. A Tentative List of Worldwide Bagasse Pulp Mills - 1988

Country	Mill	Address
Argentina	Argentina S.A. (Celulosa)	Aristobulo del Valle 594 Zarate, Pcia Bs.As. Tel: 0328-2987/8/2950
	Azucarera del Norte S.A. (Cia)	Belgrano 990, 4 Piso Bs.As.Cap. Tel: 38-2194/0483, 37-7948
	Ledesma S.A.A.I.	Sarmiento 440 Tel: 456011
Bangladesh	North Bengal Paper Mill Ltd.	P.O. Paksey Dist. Pabna Tel: ISHURDI 441
Brazil	Brasileiras Portela Cia (Industrias)	P.O. Box 1909 Cais de Alfandega 130, Recife, Pernambuco Tel: 240811, Telex: 036 821
	Guatapara S.A. Industria de Papel	Bairra Monte Alegre 13400 Caixa Postal 65, Piracicaba, Sao Paulo Tel: 3-2822, Telex: 191127 refp br
	Matarazzo de Embalagens S.A (Industria)	Estacao Comendador Ermelino Matarazzo S/N, Sao Paulo, S.P. Tel: 206-4433
	Portela (Companhia Industrias Brasileiras)	Cais de Alfandega 130 Recife, Pernambuco

Colombia	Productora de Papeles (Propal), S.A.	Apdo Aereo 4412 Cali
Cuba	Papelera Damughee	No reference
India	Central Pulp Mills Ltd.	Fort Songadh, Dist-Surat (Gujrat) Pin 394660
	Mandya National Paper Mill Ltd.	Belagula 571606 Karnataka, Tel: 34 42 45 Belagula, Telex: 0846-228
	Pudumjee Pulp and Paper Mills Ltd.	Thergaon Chin Chwad, Poona 411033 Tel: 83289, Telex: 0145-325 gpgl
	Rohit Pulp and Paper Mills Ltd.	Bombay, 400 001
	Sehsasayee Paper and Boards Ltd.	Erode, 638007 Salem District, Tamil Nadu
	Tamil Nadu Newsprint and Papers Limited (TNPL)	No reference
	West Coast Paper Mill Ltd.	Dandeli, 581362 Karnataka Tel: 191/95, Telex: 0865-240 wcpm in
Indonesia	Perusahaan Negara Kertas Letjes	Leces Probolinggo East Java, Tel: PROBOLINGGO 161, Telex: 31-386

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Mexico	Kimberley Clark de Mexico S.A.	Escamela Municipio de Ixtaczoquitlan, Veracruz Tel: 528-55, Telex: 015-415
	Mejicana de Papel Periodico (Mexpapel)	Cordoba No. 23, 2nd floor Mexico 06700 D.F. Tel: (5) 5336843, Telex: 01772961 mepd me
	Productora de Papel S.A.	Km 7 Ant. Carret. Roma San Nicolas de Las Garzas P.O. Box 867, Monterrey Tel: 762020
	CIA Industrial de San Cristobal S.A.	Av. Benjamin Franklin 132 Mexico D.F. Tel: 515-8560, Telex: Decuci 017-71-046
	Titan S.A. (Empaques de Carton)	P.O. 757 Av. Universidaad 2071 Norte Monterrey Neuvo Leon Tel: 753111
Peru	Trujillo S.A. (Cia Papelera)	Casilla 130 Trujillo Tel: 231461, Telex: 25485 Pe Para Lima
Philippines	Central Azucarera de Bais (Paper Div.)	Bais Central Negros Oriental T.A. Celulosa - Bais Central
	United Pulp and Paper Co., Inc.	Kin 48 McArthur Highway, Calumpit Bulacan, Tel: 408874

South Africa	Sappi Fines Papers (Pty) Ltd.	Stanger Mill P.O. Box 725, Stanger Natal 4450, Tel: (0324) 23011, Telex: 6-05 35 S.A.
Taiwan	Pao Lung Pulp and Paper Co.	489 Fuhsing N. Road Taipei Tel: (02) 715-3191, 715-5055, Telex: 25776 Paolung
	Pingtung Pulp Factory	25 Pao Ching Road 1 Taipei 100 Tel: (02) 3110521, Telex: 11270 Taisuco

APPENDIX B A TENTATIVE LIST OF THE MAIN BAGASSE PULP AND PAPER PLANTS OPERATING IN 1980

COUNTRY	NAME OF COMPANY	LOCALITY	END PRODUCT	CAPACITY (T/24 Hr)	PROCESS	CHEMICAL RECOVERY	STARTED OPERATING	YEARLY PRODUCTION (tonnes)	REMARKS
ARGENTINA									
	Celulosa Argentina SA	Tucuman	BU	20	Soda	No	-	1,000	Modified Soda Process
	Celulosa Argentina SA	Rosario	BB	75	CSC	No	-	-	Celdecor Process
	La Papelera del Norte	Tucuman	BU	20	Soda	NO	-	1,500	-
	Ebro Mill	Santa Fe	BB	25	Mestres	No	1943	-	Modified Soda Process
	Ledesma SS Agricola y Industrial	Jujuy	BB	100	Kraft	Yes	1965	-	Pandia Digesters
BANGLA DESH									
	North Bengal Paper Mill	Parksey	BB	50	-	Yes	-	10,000	-
BRAZIL									
	Celubagaco Industria e Comercio SA	Campos	BHY	-	Soda	-	-	-	W.R. Grace
	Fabrica de Papel e Cellulose Morganti	Picacicaba	-	20	Soda	-	-	-	-
	Industrias Reunidas SA	Matarazzo	BU	20	-	No	-	3,000	-
	Rifinadora Paulista SA	Piracicaba	BB	50	CSC	No	1952	6,000	-
	Rigesa Cellulose e Papel Ltda	Sao Paulo	BU	100	-	No	-	18,000	-
	Cia Industrias Brazileiras Portella SA	Fernambuco	BU	60	-	No	-	10,000	-
	Papelao Ondulato do Nordeste SA	Recife	BHY	100	-	-	1978	-	-
	-	Alagoias	BB	100	Kraft	Yes	1979	34,000	-
CHINA (People's Republic of)									
	Pearl River Paper Company	Canton	BHY	40	CSC	No	1960	-	-
COLUMBIA									
	Productora de Papeles SA	Cali	BB	250	Kraft	Yes	-	50,000	-
	W.R. Grace and International Paper Co	-	BB	80	Soda	Yes	1961	-	-
COSTA RICA									
	-	Turrialba	BB	60	-	-	1967	-	-
CUBA									
	Sergio Gonzales Factory	Las Villas	BHY	45	Soda	No	1957	10,000	-
	Papelera Pulpa Cuba	Trinidad	BU	100	Kraft	Yes	1960	18,000	Pandia Digesters
	Technica Cubana SA	Cardenas	BB	90	Kraft	Yes	1959	18,C00	-
	Experimental Mill		BB						
ECUADOR									
	Papelera Nacional SA	Guayaquil	BHY	25	-	-	1967	5,000	-

Source: (1.3)

APPENDIX B (continued)

COUNTRY	NAME OF COMPANY	LOCALITY	END PRODUCT	CAPACITY (T/24 Hr)	PROCESS	CHEMICAL RECOVERY	STARTED OPERATING	YEARLY PRODUCTION (tonnes)	REMARKS
INDIA									
	[illegible]	[illegible]	[illegible]	[illegible]					

[illegible]	-	Turrialba	BB	60	-	-	1967	-	-
CUBA	Sergio Gonzales Factory	Las Villas	BHY	45	Soda	No	1957	10,000	-
	Papelera Pulpa Cuba	Trinidad	BU	100	Kraft	Yes	1960	18,000	Pandia Digesters
	Technica Cubana SA	Cardenas	BB	90	Kraft	Yes	1959	18,000	-
	Experimental Mill		BB						
ECUADOR	Papelera Nacional SA	Guayaquil	BHY	25	-	-	1967	5,000	-

APPENDIX B (continued)

COUNTRY	NAME OF COMPANY	LOCALITY	END PRODUCT	CAPACITY (T/24 Hr)	PROCESS	CHEMICAL RECOVERY	STARTED OPERATING	YEARLY PRODUCTION (tonnes)	REMARKS
INDIA									
	Bengal Paper Mill Co Ltd	Raniganj	BB	25	-	-	-	-	-
	Mandya National Paper Mills Ltd	Belagola	BB	50	Kraft	Yes	1962	11,000	-
	Northern India Paper Mills Ltd	Meerut	BB	60	Kraft	Yes	1963	-	-
	Rohtas Industries Ltd	Dalmianagar	BB	200	Kraft	Yes	-	60,000	-
	Seshasayee Paper and Board Ltd	Erode	BB	100	Kraft	Yes	1963	35,000	Pandia Digesters
	Ballarpur Paper & Straw Board Mills Ltd	Yamunanagar						51,000	
IRAN									
	Pars Paper Company	Haft Tappeh	BB	60	-	Yes	-	18,000	-
IRAQ									
	Basrah Pulp and Paper Mill	Basrah	BU	60	-	No	1967	-	-
		Misan	BU	300	Kraft	Yes	1978	85,000	-
MEXICO									
	Cia Industrial de Ayolta SA	Ayolta	BB	100	-	-	-	-	-
	Fabrica de Cellulosa El Pilar SA	Mexico	BB	75	CSC	No	1953	20,000	-
	Cia Industrial de St Cristobal SA	Ecatepec	BB	230	Simon-Cusi	Yes	1952	40,000	-
	Kimberley Clark de Mexico SA	Orizaba	BB	200	-	Yes	-	30,000	-
	Productora de Papel SA	Monterrey	BHY	60	-	-	-	-	-
PAKISTAN									
	Pakistan Paper Corp. Ltd	Charsadda	BB	100	-	Yes	1970	15,000	-
	Pakistan Paper Corp. Ltd	Jamshora	BB	100	-	Yes	1979	-	-
PERU									
	Cellulosica y Papelera del Norte	Cayalti	BU	25	Mestres	No	1952	5,000	Modified Soda Process
	Cia Papelera Trujillo SA	Trujillo	BHY	200	Peadco	-	1969	45,000	-
	Sociedad Agricola Paramonga Limitada	Paramonga	BB	125	Peadco	-	-	30,000	-
	Induperu SA	Chiclayo	BB	350	-	Yes	1978	-	-
PHILIPPINES									
	Central Azucarera de Bais	Negros	BB	40	CSC	-	1941	10,000	-
	United Pulp and Paper Co.	Calumpit	BU	100	Kraft	-	1973	18,000	-
PUERTO RICO									
	Pan American Paper Mills Co	Arecibo	BHY	60	Soda	No	1959	10,000	Modified Soda Process
SOUTH AFRICA									
	Ngoye Paper Mills (Pty) Ltd	Felixton	BHY	200	Soda	Yes	1956	30,000	-
	Stanger Pulp and Paper (Pty) Ltd	Stanger	BU	138	Kraft	Yes	1976	34,000	Coated Paper

APPENDIX B (continued)

COUNTRY	NAME OF COMPANY	LOCALITY	END PRODUCT	CAPACITY (T/24 Hr)	PROCESS	CHEMICAL RECOVERY	STARTED OPERATING	YEARLY PRODUCTION (Tonnes)	REMARKS
SPAIN									
	Empresa Nacional de Cellulosa	Montril	BHY+BB	50+40	Kraft+ CSC	-	-	15,000 T (+ BHY) + 10,000 T(BB)	
TAIWAN									
	Pingtung Pulp Factory (Taiwan SC)	Pingtung	BB	300	Kraft	Yes	1977	60,000	-
	Hsingying Pulp & Paper Factory (TSC)	Hsingying	BB	150	Kraft	Yes	1940-1958	45,000	-
	About 39 small mills use bagasse	-	Bd+BU+BHY	-	-	No	-	60,000	-
THAILAND									
	Sian Kraft Paper Co Ltd	Ban Pong	BU	70	Kraft	Yes	1967	21,000	-
UNITED ARAB REPUBLIC (EGYPT)	Al Nasr Co	EDFU	BU	60	Kraft	No	1965		
UNITED STATES	Valentine Pulp & Paper Co	Lockport	BB	150	Soda	Yes	1952	36,000	
VENEZUELA	CA Venezolana de Pulpa de Papel	Moron	BU	150	Kraft	No	1963	30,000	Pandia Digesters
	Guanare Papelera	Rio Guanare	BB	150	Kraft	Yes	1978	35,000	-

N.B.

BHY = Bagasse high yield pulp for corrugating medium and liner board

BU = Bagasse fully cooked unbleached pulp for wrapping paper, bag paper, etc

BB = Bagasse bleached pulp for writing and printing papers

APPENDIX C A TENTATIVE LIST OF THE MAIN BAGASSE BOARD PLANTS OPERATING IN 1980

COUNTRY	NAME OF COMPANY	LOCALITY	PROCESS	END PRODUCT	CAPACITY (T/24 Hr)	STARTED OPERATING	REMARKS
ARGENTINA	Cia Azucarera Tucumana	Tucuman	[illegible]	Particle Board	[illegible]	[illegible]	

INDIA

Tamil Nadu's new mill, which started last year, is claimed to be the first in the world successfully to use a high proportion—50%—of bagasse mechanical pulp in its newsprint furnish. By N.D. Misra.

TNPL solves bagasse pulping problem

TECHNICAL INNOVATION is the hallmark of Tamil Nadu Newsprint and Papers Ltd. (TNPL), a new bagasse-based newsprint mill located at a 150-ha site beside the river Cauvery near the town of Pugalur in the state of Tamil Nadu, in India.

According to managing director C. Ramachandran and executive director M.V.G. Rao, TNPL is innovative in two main ways. First, and most importantly, this is the only newsprint mill in the world where mechanical pulping of bagasse has been adopted and put successfully into practice on a full industrial scale. In India, it is one of the first newsprint mills to make use of an important local resource—bagasse. Estimates put the amount of bagasse currently available from the Indian sugar industry at 19 million tons/yr.

Regular production at TNPL started on 24 May 1985, when the chief minister of Tamil Nadu state, Dr. M.G. Ramachandran, dedicated the mill to the nation. During its first year of operation, TNPL had a turnover of approximately $47 million, with production running at 63,000 tons of newsprint and printing and writing papers, corresponding to about 70% capacity utilization. At full production, a mix of 50,000 tons/yr of newsprint and 40,000 tons/yr of printings/writings will be made on the mill's 6.8-m trim Beloit Walmsley twin-wire PM.

A public limited company brought into being under the auspices of the state government, TNPL was developed with consultancy services from Seshasayee Paper and Boards (SPB), the leading paper mill in Tamil Nadu. Total investment cost was around $200 million.

It took only two years from the start of civil construction in September 1982, to the first production trials, using imported pulp, in September 1984. Subsequently, in 1985, trials were held with the mill's own chemical and mechanical bagasse pulps.

Tamil Nadu: the first mill in the world to use mechanical bagasse pulp successfully in the manufacture of newsprint.

To record the mill's achievements, an international seminar, held in April this year, and organized by SPB consultants, discussed the history and future of bagasse as a raw material.

What makes TNPL unusual is the use of a very high proportion of mechanical bagasse pulp in the furnish. Following advice from its consultants the mill saw that only with a high mechanical pulp content could it meet the opacity and bulk requirements of newspaper printers.

Tests by SPB consultants and Beloit Jones showed that a furnish which would give the necessary qualities could be obtained from 50% mechanical bagasse pulp, 35% chemical bagasse pulp, and 15% chemical hardwood pulp, using eucalyptus wood. And semi-commercial trials in the USA showed that the newsprint produced would have the required runnability in printing presses.

As a result, a new mechanical pulping process, called the Beloit-SPB system has been implemented at TNPL. It uses thermomechanical pulping (TMP) of the bagasse, with chemi-mechanical pulping (CMP) of the coarse fraction.

Shipments of loose or compacted bagasse are supplied by local sugar mills, located on average about 65 km from the mill. Annual consumption is estimated at 400,000 tons/yr. After screening in two Radar disc type classifiers, bagasse is sent for moist depithing in two carousels, each with six 16-ton/-hour vertical depithers. The separated pith is burned in multifuel boilers, which can also burn lignite, charfine, oil and coal if necessary.

Prepared bagasse is wet piled, in storage slabs of average size 540 x 90 m and 5 m high. Total storage capacity is 143,000 bone-dry tons. Retrieval from the stockpile is by Farukawa front-end loaders. Before pulping, the retrieved bagasse is washed in four aqua washers from Beloit Jones.

The TMP line consists of two 110-ton/day 1.42-m (56-in.) pressurized Beloit Jones refiners, followed by three

Beloit HD pressure screens and three-stage Bird centricleaning. The pulp is thickened in in a Hedemora disc-type thickener with eight 3.6-m discs. The coarse fraction from the TMP line is sent to the CMP line where it is pretreated with alkali. The line itself is centered around a 1.42-m, 100-ton/day, Beloit Jones refiner at atmospheric pressure, followed by two-stage screening with Bird pressure screens and two-stage cleaning with bagasse cleaners. Thickening and washing is by a 3-m diameter Hedemora drum filter with a 4-m face-width. TMP and CMP fractions are combined after washing and then bleached with hydrogen peroxide to 45° ISO brightness.

Chemical pulp lines

Chemical bagasse pulp is made in the conventional way, in two 125-ton/day horizontal Sunds Defibrator continuous digesters. After three-stage washing, three-stage cleaning, pulp is bleached by a CEH system to 75° ISO brightness. The equipment was supplied by Hindustan Dorr-Oliver and includes three drum-type pulp filters, 3.5-m diameter and 7-m face-width.

The chemical hardwood pulp line uses about 72,000 tons/yr of eucalyptus, bought from forests owned by the State Forest Development Corp. The wood is chipped in two 60-m³/hour disc-type Carthage chippers. After screening, they are stored in a single storage silo.

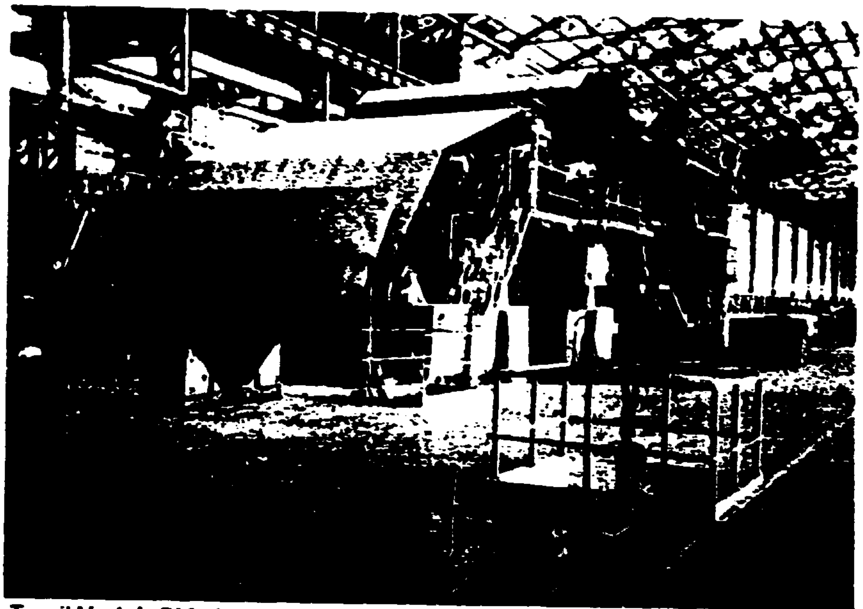
The mill has two 80-m³ capacity Utmal stationary vertical batch digesters, for conventional kraft cooking of the eucalyptus chips. Pulp is washed and screened then bleached in a CEHH sequence with four 2.4-m diameter, 3.7-m long Hindustan Dorr-Oliver pulp mixers.

Recovery of chemicals is by a recovery boiler supplied by Mitsubishi Heavy Industries. It has capacity of 285 tons/-day of black liquor dry solids, and can also produce 34.7 tons/hour of steam at 44 kg/cm² and 440°C. The mill also has three Babcock boilers capable of generating 60 tons/hour at the same pressure and temperature. The mill also has two turbo-generators from Siemens, one rated at 8 MW and the other at 18 MW. The recausticizing line is built by Hindustan Dorr-Oliver and has a capacity of 800 m³/day of white liquor.

LABORATORY TEST DATA; FOR NEWSPRINT PRODUCED ON THE TNPL MACHINE

Basis weight (g/m²)	52.8
Caliper (µm)	81
Bulk (cm³/g)	1.53
Ash (%)	6.0
Breaking length (m):	
machine direction	4,200
cross direction	1,880
Tear factor (m):	
machine direction	33
cross direction	39
Burst factor	13
Smoothness (ml/min)	
top wire	270
bottom wire	180
Porosity (ml/min)	280
Brightness (% ISO)	50.5
Opacity (%)	90.9
Scattering coefficient (m²/kg)	37.4
Yellowness (%)	24.4
Furnish (%):	
Mechanical bagasse	50
Chemical bagasse	35
Hardwood	15
Machine speed (m/min)	600

Trial made on 16 March 1986, roll number 284. The paper was subsequently used in a modern four-color offset printing press at the newspaper The Hindu, at a printing rate of 35,000 impressions/min.



Tamil Nadu's PM trims at 6.8 m and is rated at 50,000 tons/yr of newsprint and 40,000 tons/yr of printing and writing papers.

Paper machine trims at 6.8 m

The Bel-Baie II twin-wire PM has a trim width of 6.8 m. It is rated at 357 tons/day of 50-g/m² newsprint at a maximum speed of 750 m/min, or at 303 tons/day of 56-g printing and writing paper. The PM's wet end includes a Converflo headbox, the Bel-Baie and a tri-nip press. Its dryer section has 43 drying cylinders in four groups, with an inclined size press added between the third and fourth groups for making Maplitho and other printings/writings grades. There is a four-roll on-machine calender.

Computer control for the PM is by an AccuRay Micro 1180 system and includes basis weight, moisture and dry stock functions.

After the machine there is a 6.7-m trim Beloit slitter/winder with a maximum operating speed of 2,000 m/min. Reels of up to 1.2-m diameter are produced. There is also a Lenox salvage winder. The reel handling system was provided by Kone and can handle up to 40 reels/hour. Reels are fed to the Lamb wrapping machine.

Because of its involvement in printings/writings, the mill also has a sheeting line with two Jagenberg Convo 316 sheeters.

The mill has a full effluent treatment plant, again from Hindustan Dorr-Oliver, handling nearly 60,000 m³/day of effluents to the standards required by the state pollution control board. Average freshwater consumption is around 200 m³/ton of paper. Since the clarified paper mill effluent is suitable for irrigation, particularly for the paddy, sugar cane and coconut crops, TNPL is planning to divert it to farmers to improve their crop yield.

NEWSPRINT

Originally set up to replace imports with domestic production, Mexico's 395,000-ton/yr Newsprint Group is now in a position to export. Xavier Llamas talked to Pipsa, the industry's coordinating body.

Mexico's three mills set to export

The state-owned Newsprint Group in Mexico is made up of Productora e Importadora de Papel (Pipsa) in charge of marketing and sales activities and three producing companies: Fábricas de Papel Tuxtepec (Fapatux), Mexicana de Papel Periodico (Mexpape) and Productora Nacional de Papel Destintado (Pronapade). Fapatux has two subsidiaries: Silvicola Magdalena (Silma), in charge of its forestry plantations, and Etla, a producer of wood products and wood chips from pine and tropical species.

Newsprint production in 1985 was 325,000 tons in two main grades, newsprint proper and text book grade. Basis weights range from 48.8 to 100 g/m^2. This volume was attained with five PMs, installed at the three producing companies. Each company uses a different raw material. Fapatux uses wood, Mexpape uses sugar cane bagasse, and Pronapade uses deinked pulp. Local raw materials accounted for $51.5 million of the total outlays of $131.5 million made by the group during the year 1985.

Pipsa, the marketing and sales company is located in Mexico City, while the producing companies are located in three different states of Mexico: Oaxaca, Veracruz and San Luis Potosi. Pipsa was born in 1935 partly as an answer to speculative movements which frequently caused artificial shortages in the newsprint market. It also met an urgent need to make basic materials available to the editorial and graphic arts industries at the best possible terms.

The Mexican government, newspapers and editors of books and magazines participated in Pipsa's formation. Almost all the paper used by newspapers and editors at that time was imported, and considerable time, effort and investment was necessary to be able to operate properly. Also a sizeable black market had developed.

As its name indicates, Pipsa was given the responsibility to produce, import and maintain sufficient stocks for the timely supply at the best possible price and in the quantities and qualities required by the publishers of newspapers, books and magazines. From the beginning, studies of domestic pulp and newsprint production were made. In line with these responsibilities, Pipsa suppoted the foundation of Fapatux in 1958.

PM 1 at Fapatux is a 70,000-ton/yr Black Clawson unit.

After the international paper industry crisis of 1973–74, studies were initiated for newsprint manufacturing using recycled newspapers. The project was completed in 1976 with the startup of PM 1 at the Pronapade mill. PM 2 was started in 1982. Pronapade is a joint investment between the federal Mexican government which owns 51% through Pipsa, and Garden State Paper, USA, and Media General, USA, which own the other 49%.

Pipsa also participated from the beginning in the creation of the third newsprint producer, Mexpape, which process sugar cane bagasse to produce part of its furnish.

Since 1984, Papatux, Mexpape, and Pronapade, have been coordinated by Pipsa, forming collectively the Newsprint Group in Mexico.

Located in the lower part of the Papaloapan river valley in Tuxtepec, Oaxaca, Fapatux began its operations in September 1958. It uses "patula" pine from the conifer virgin forest of the Juarez Sierra in the State of Oaxaca to produce groundwood furnish. The initial newsprint capacity was 100 tons/day with a furnish of 80% stoneground wood and 20% semibleached sulfate pulp.

A clearcut forestry operation was started using motorized saws, towers with cables for the moving the complete trunks, and special hoists to load the trunks onto trucks. The wood preparation area originally had tables for receiving long trunks, debarkers with knives, a disk saw and a splitting axe.

This method was abandoned as the clearcut system was replaced by selective cutting to increase the use of local labor in the forestry operation. Trunks were then debarked, cut, split and loaded manually in the field.

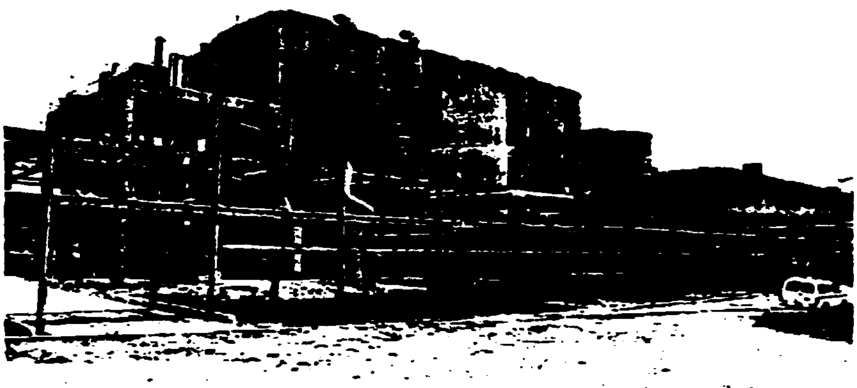
The stone groundwood plant consists of four Roberts-type grinders of 2,240 kW each, two vibratory screens, three Cowan primary and one secondary screens and four gravity thickeners. Stock preparation equipment includes a Hydrapulper, conical refiners for pulp and broke, an automatic proportioning stock system, and a finishing Jordan.

The Black Clawson paper machine was originally designed for 335 m/min to produce 100 tons/day of 52 g/m^2 paper. Its finished trim is 4.2 m. The machine had three selectifier screens, a pressurized flow headbox, cantilever fourdrinier, two suction presses, 30 paper dryers, six felt dryers, one eight-cylinder closed calender, pope reel and rewinder, mechanical transmission driven by a steam turbine and a totally-enclosed hood.

Production for the official text book 60 g/m^2 grade was started in 1960. In 1964, capacity was increased to 180 tons/day by adding two Robert's grinders, modifying the Cowan installation, installing a disc thickener, a bleaching tower, and a second pulp conical refiner. Also several important modifications were made to the paper machine. In 1966, two ponds for wood storage were built, and a Deculator cleaner system was installed in 1968.

Then, in 1975, a refiner groundwood plant was built to produce an additional 40 tons/day. On the PM a suction pick up press was installed and other modifications were also made to increase the capacity to 70,000 tons/yr.

A 330-ton/day thermomechanical pulp (TMP) line was installed in 1983, consisting of three two-stage Bauer refiner lines, two pressurized screens, disc thickners and a bleaching tower. Early in 1984 PM 2, a 100,000-ton/yr Beloit Bel-Baie unit built in Japan by Beloit Mitsubishi, was installed. This twin-wire PM has a 6.4-m trim, and a design speed of 920 m/min. It produces both newsprint and official text book grades. Total present installed capacity at Fapatux is 170,000 tons/yr.



Mexpape's bagasse pulp line receives raw material from three local sugar mills.

Mexpape one of first to use bagasse

Also located in the lower part of the Papaloapan river valley in Tres Valles, in the south of the State of Veracruz, Mexicana de Papel Periodico is only 30 km from Fapatux. The equity of this company is owned 60% by the federal government and 40% by Nacional Financiera, a government development agency.

The mill has a capacity of 100,000 tons/yr and produces 52 g/m^2 newsprint, 60 g/m^2 textbook and 60 g/m^2 rotogravure grades, using sugar cane bagasse pulp, groundwood and semi-bleached softwood kraft as furnish.

Mexpape began its operations in July, 1979, producing official text book with 65% bagasse pulp, 25% groundwood and 10% kraft and 7% filler clay. It is presently producing 52 and 49 g/m^2 newsprint, with a furnish of 55% bagasse, 35% mechanical, 10% kraft pulp and 6% filler. These grades have satisfactory quality and runnability in the printing presses.

The sugar cane bagasse is obtained from the Tres Valles Sugar Mill (located next to Mexpape) which sends the material through a belt conveyor to the pulp mill. Other sources are the Adolfo Lopez Mateos sugar mill, 25 km away, and the Impulsora de la Cuenca del Papaloapan, formerly San Cristobal, sugar mill, 54 km away. Bagasse from both mills is transported in specially designed trailers.

Mexpape has six vertical depithing units where a high percentage of the pith is removed. The accepted fiber is unloaded to dilution pits from which the fiber suspension is pumped to build the bulk storage piles. The sugar mills operate only 6–7 months/yr, so, at the end of the harvest season, these storage piles are at full capacity.

Stored fiber is moved by front loaders to the reclaim pits from which fiber in suspension is pumped to the washers. Washed fiber is discharged by gravity to a tank, and pumped through a double screw press to the two-tube American Defibrator continuous digester where caustic and steam are added.

Pulp is blown to a cyclone and blow tank. It is washed in two stages, then stored before two-stage screening. Accepts go to a third washer/thickener. Screened pulp goes through two-stage bleaching with sodium hypochlorite. The semibleached pulp is stored in a medium-consistency tower before being fed to the PM.

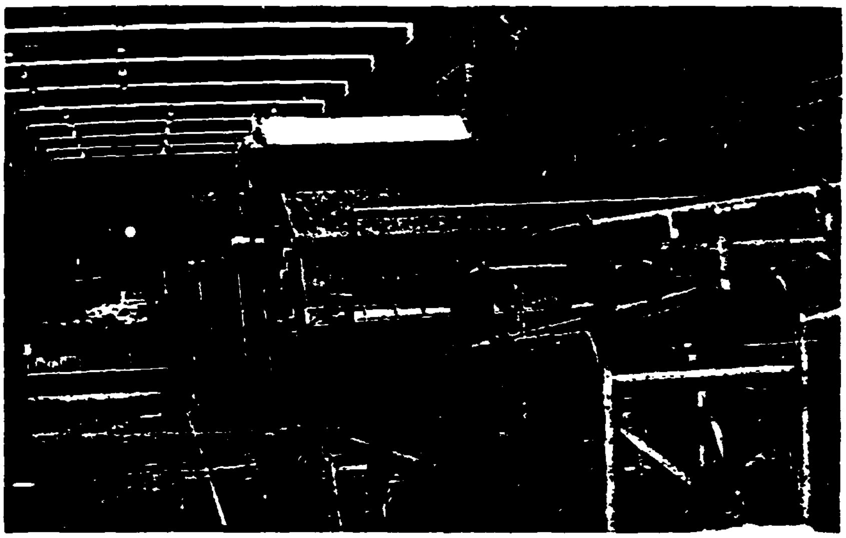
The stock preparation system includes: a kraft Hydrapulper, groundwood hydropulper, kraft pulp refining, deflakers, and automatic stock proportioning system and Deculator cleaner system ahead of the paper machine. There is also a clay suspension preparation system.

The machine, a Beloit Bel Baie II has a design speed of 810 m/min, and a finished trim of 6.1 m. It has a Trinip press, 33 dryers, four-roll versa nip calender, and a totally enclosed hood. The recovery system includes a four-stage evaporator system from which a Copeland fluidized bed reactor is fed. Solids from the reactor go to a dissolving tank and are sent to a conventional recausticizing system.

Pith from bagasse is burned in a specially-designed boiler. The mill has two power boilers and two turbo generators which supply 85% of the total electricity required by the mill. Fresh water intake from the river is treated before entering the process. The mill has primary effluent treatment.

Pronapade: 100% wastepaper furnish

Pronapade's mill is located in the Villa de Reyes district, 52 km from the



The 6-m Beloit PM at Mexpape was one of the first to produce newsprint using bagasse furnish.

city of San Luis Potosi and about 450 km from Mexico City. It began operations in 1976, with two PMs and a total capacity of 133,000 tons/yr. PM 1 makes 73,000 and PM 2 60,000 tons/yr. Fibre is 100% used newsprint collected in Mexico or imported from the USA.

Once the newsprint waste has been selected and inspected, i. is fed to three Hydrapulpers where deinking chemicals are added. Stock is discharged through extraction plates to a storage tank and then processed through a centricleaner to eliminate heavy contaminants. Stock goes through deflakers and is diluted for further cleaning by vibrating screens. Screened stock is fed to a three-stage counter current conventional drum washing system.

Washed stock is bleached and stored to feed the paper machines. PM 1 has trim of 6.1 m, and PM 2 5.55 m, and run respectively at 488 and 457 m/min.

The mill uses fresh water from deep wells which has the peculiarity of being at high temperature, so allowing some energy savings. The mill generates about one third of its electrical power requirements.

Short and medium term plans

In 1984, Pipsa, in addition to producing, distributing and regulating the newsprint market, was given the responsibility of coordinating the activities of the Newsprint Group. That same year, imports of newsprint were eliminated and replaced by local production. This constituted a great step forward, and an important change for the country.

This year, Pipsa has started an export program of about 20,000 tons of both newsprint and text book grade into Central and South American markets. The US South may be included in a future program. This has been possible due to the group's efforts in reducing production costs and improving product quality. Additionally, this year the group will complete trials which will permit the manufacture of other similar paper grades.

The Newsprint Group produced 267,700 tons in 1984 and 325,000 tons in 1985, an increase of 57,300 tons or 22%. For 1986 the estimate is 360,000 tons, up 35,000 tons or 11%. In 1987, programs already under way will permit production of 395,000 tons, 10% more than in 1986.

As can be seen, the Newsprint Group is committed to a dynamic growth which is basically determined by the development of both the Mexican and export markets. Up to April 1986, production had reached 116,000 tons. So it seems possible to achieve the 360,000 tons planned for the year. These first four months of production represent a 16% rise over the same period in 1985 and 48% over that of 1984.

Analyzing the trends by company, Fapatux produced 44,000 tons more in 1985 (56%) than in 1984, mainly due to increases from PM 2. For 1986, expected production is 145,000 tons, 84% higher than 1984. The 170,000 tons projected for 1987 are an increase of more than 86,000 tons or 116% over 1984.

To reach that production level, a modernization program for PM 1 will be implemented. It includes replacement of some major components and replacing the fourdrinier with a twin wire.

Mexpape produced 77,790 tons in 1985. The volume programmed for 1986 is 90,000 tons which represents 16% increase over 1985. It seems even higher volumes will be obtained. In the first four months of the year, nearly 29,500 tons have been produced, with more than 8,000 tons monthly in March and April. This trend reinforces the 1987 forecast level of 100,000 tons of 48.8 g/m^2 and 60 g/m^2 paper to be used both in newsprint and books, like the free official grade school textbook.

When Mexpape began operations in 1979, it was with a semichemical process for bagasse in which Mexico was a pioneer. But it was not possible to achieve the desired production level with the semichemical process. It was therefore decided to convert the process to a conventional chemical type. During 1985 the mill was able consistently to operate the caustic recovery system, and generated important savings. It is projected for this year to continue improving the recovery of chemicals to generate additional savings of approximately $1 million.

Pronapade has been in the past the most important company of the group from the production volume point of view. It produced about 114,000 tons in 1984 and 124,000 (8% increase) in 1985, exceeding its budget for the year.

In 1986, the mill will produce 129,000 tons and in 1987, 133,000 tons, 3 and 7% rises, respectively over 1984. During the first four months of this year 4,800 additional tons compared with the same period of 1985 have been produced.

The Newsprint Group will continue to supply of domestic demand, which is growing at an average of 8% per year. Its capacity utilization will be 90% in 1986 and, as of 1987, 100%. Production will be of international quality and at competitive prices. Any future expansion project will maintain and, if possible, increase participation in export markets, despite the fact that the creation of Pronapade, Mexpape and the purpose of replacing imports only.

VI SOME EQUIPMENT SUPPLIERS AND CONSULTANCY SERVICES :

- Equipment suppliers :	Address
1. AUSTRIA :	
Voest Alpine	P.O.Box 2, A-4010 Linz Tel. (0732) 585-1, Tx. 2209243 vaa /2207449 vaa
2. FRANCE :	
Lamort S.A.	Boite Postale 46 F-51302 Vitry Le Francois-Cedex Tel. (26)74-1630 Tx. 830731 Mecal, Vitof
3. JAPAN :	
-Hitachi Zosen Co.	Palaceside BLdg.7F 1-1,Hitotsu Bashi 1-Chome Chiyoda-Ku Tokyo 100
-Ishikawasima-Harima heavy Industries Co. Ltd.	Shin-Ohtemachi BLdg, 2-1,2-Chome,Ohtemachi, Chiyoda-ku Tokyo 100 Tel. Dialin 244-5345 Tx. 22232
-Mitsubishi Heavy Industries Ltd. (Mitsubishi Paper Mills)	5-1,Marunouchi 2-Chome Chiyoda-ku Tokyo 100 Tel. 03-212-3111 Tx. J22282
4. SWEDEN :	
-Hedemora AB	S-77600 Hedemora Tel. (0225)12000 Tx. 7549
-Sund Defibrator AB	S-851 01 Sundsvall Tel. 060/56 7200 Tx. 71053 sunds s

5. UNITED KINGDOM :

-Beloit Walmsley Ltd.	Wood Street/Bury Lancs BL8 2QT Tel. 061-7646060 Tx. 667061
-Bollmann and Potomac Ltd.	159 High Street/Torbridge Kent TN9 IBX Tel. (0732)3515 98 Tx.957582 bolmac

6. USA :

-Black Clawson, Inc.	P.O.Box 1028 Everett, Wa 98206 Tx. 32-8879
-Copetech Inc.	125 Windsor Drive Oak brook, Illinois 60521

7. WEST GERMANY

-Kraftanlagen Heidelberg.	Warrengauerstr. 47 Munich 90 Telex 522400 ka d
-Sulzer Escher Wyss G.m.b.H.	P.O.Box 1380 D-7980 Rauensburg
-J.M. Voith G.m.b.H.	St. Poltener Str.43 D-7920 Heidenheim

- Consultancy Services :

1. CANADA

Hurter Fibre Consultants Inc.	255 Albert St.,Suite 802 Ottawa, Canada K1P 6A9 Tel. (613)230-8088 Tx. 0534928

2. INDIA

-Godavany Consultance Services	Bombay
-Mandya National Paper Mill Ltd.	Belagula 571606 Karnataka
-Seshasayee Paper and Boards Ltd.	Erode 638007 Salem District Tamil Nadu

3. UNIDO	Vienna International Centre P.O. Box 300 A-1400 Vienna, Austria

4. USA :

-Joseph E. Atchison Consultants Inc.	No reference
-Peadco process Evaluation and Development Co.	Two Galleria Tower suite 1500, 13455 Noel Road Dallas Tel. (214)770-0285 Tx. 735-316 Peadco Dal Ud

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   South Melbourne
   3205

3. BRAZIL
   IPT Centro Tecnico em celulose e papel
   Caixa Postal 7141
   0100 Sao Paulo, S.P.

4. CUBA
   Instituto Cubano de Investigacion de los Derivados de la
   Cana de Azucar (ICIDCA)
   La Habana

5. EGYPT
   University of Cairo
   Dept. of Chemistry
   Giza

6. FINLAND
   Enso-Gutzeit oy Research Center
   Sf-55800 Imatra 80

7. GUATEMALA
   Instituto Centroamericano de Investigacion y Tecnologia
   Industrial (ICAITI)
   Av. la Reforma 4-47. Zona 10
   Guatemala City

8. INDIA
   -Cent. Pulp. Paper Research Institute
   New Delhi
   -Institute of paper Technology
   Saharanpur-240 001 (UP)

9. INDONESIA
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10. JAPAN
-Agency of Industrial Science and Technology
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-Institute of Pulp and Paper Industry
Shizuoka, prefecture

11. MEXICO
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12. SOUTH AFRICA
National Timber Research Institute
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13. THAILAND
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Bangkhen, Bangkok 10900

14. TAIWAN
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54 Sheng Chan Rd.
Tainan 700

15. USA
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P.O.Box 1039
Appleton, WI 54912

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JETRO

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Benn Business Information Services Ltd.

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