Depithed bagasse–Future raw material for Dissolving grade pulp

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ABSTRACT

Bagasse is drawing the attention of Cellulose Industries as a potential raw material and has already proved its application in Paper Indnstries. Tamilnadu Newsprint and Papers Limited and many other paper mills are using bagasse in newsprint and paper manufacture. A study has been undertaken to find out the suitability of bagasse for producing dissolving grade pulps by acid sulphite cooking (calcium base) and the results are discussed.

Introduction :

With the dwindling of traditional raw materials and increased awareness towards preservation of ecology, the Pulp and Paper industry has to explore environment friendly, economic and renewable cellulosic sources to meet the demands. Naturally agricultural residues are the possible alternatives as they are grown annually A time has come when some of these relatively low ash content and low impurity cellulosic sources can be considered to supplement the requirement for dissolving grade Pulp Production.

Bagasse is one of the waste products of sugar industry and can be exploited beneficially as a cheap source of cellulosic material. It is generated at the rate of 30 to 33% of cane crushed and presently used as boiler fuel in most of the sugar industries. Sugar industries can spare this bagasse to cellulosic industries either partly or fully depending on their fuel needs. Physical and Cnemical properties of bagasse varies based on geographic conditions and mill. The three principal components of bagasse are

— the rind including epidermis, cortex and pericycle.

— the vascular fibre bundles compr sing conducting tissues (xylem, phloem)

— Parenchymatous tissue which is non-fibrous and referred as pith.

Bagasse, as it emerges from the crusher, contains 50% moisture, 45-46% Fibre and pith and 4 to 5% solubles. Analysis of bagasse on O D. basis is shown in Table-I. Chemical composition of bagasse shows cellulose, pentosans and lignins as major components (Table II). Different degrees of polymerisation (DP) determine the nature of cellulose. Bagasse cellulose polymerisation chain is of the order of 2000–3000 units. However, for the manufacture of dissolving grade pulp a DP level of 700 to 900 is acceptable after cooking and bleaching stages. Pentosan content in bagasse is 50% higher than tropical hard woods and 3 to 4 times higher than soft woods. On the other hand, lignin content in bagasse is lower than that of hard woods and only 75% of soft woods.

Table III indicates that solubles and inorganic impurities in whole bagasse are due to the pith fraction and dirt. During wet depithing some of these get removed. Fibre fraction of bagasse is approximately 20% richer in alpha cellulose than pith fraction. Good quality fibres of bagasse have 1.02 to 1 50 mm length and about 20 microns diameter as similar to wood material This indicates that to manufacture dissolving grade pulp the fibre fraction alone has to be considered. General analytical results of conventional raw materials like Bluegum E. globulus', Wattle (Accasia mearnsii), SIV norms are shown in Table–IV.

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TABLE—I

Fibre and Pith content in Bagasse

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

TABLE–II

Proximate analysis of Bagasse Vs Bamboo

Sl. No.	Particulars	Unit	Bagasse	Bamboo
1	Ash	%	1.8–2.2	3.1
2	1% NaOH solubility	%	30–32	28.3
3	Alcohol–Benzene extract	%	1.9–3.8	4.2
4	Pentosans	%	24–28	19–20
5	Lignin	%	20–24	19–20
6	Holo cellulose	%	70–74	66–68
7	Alpha cellulose	%	40–42	45–47

EXPERIMENTAL

Depithing of bagasse :

Dry depithing is carried out by screening bagasse manually in 2 mm. screen as there is no facility to depith the bagasse mechanically in our mills. This partially depithed bagasse is used for cooking experiments.

Cooking of depithed bagasse :

We have installed a 0.7 cubic meter circulation type pilot digester with liquor preheater. This is used to batch cook partially depithed bagasse. Also Vat cooking experiments were done by suspending a perforated basket with lid in the digester to compare results with normal cooking conditions

Cooking process	:	Acid Sulphite Process with Calcium base
Cooking liquor	:	Calcium bi sulphite cooking liquor
Total SO_2	:	4.3 to 4.8%
CaO	:	1.35 to 1.40%

Basket Cooking in Plant Digester :

Maximum pressure	:	8.0 kg/Cm² g.
Maximum temperature	:	138 Deg. C
Time to reach maximum Temperature	:	7 hours.
Cooking time at maximum temperature & pressure	:	2 to 2½ hrs.

Pilot Digester Cooking :

Digester capacity = 0.7 m³. Liquor circulation type with steam heater.

Cooking conditions :

Maximum pressure	:	8 0 kg/Cm² g.
Maximum temperature	:	138—141 Deg. C
Time to reach maximum temp. and pressure	:	3 to 5½ hrs.
Cooking time at maximum temp. and maximum pressure.	:	1 to 3 hours.

Analysis of ? was carried out as per procedures outlined in "Analysis of Wood", by W. H. Dore and recommended by Snia Viscosa, Italy.

Results :

Variations in cooking conditions produce different qualities of pulp with respect to viscosity and sieber number (or "K" number). Pilot digester cooking of bagasse results reveal that about 6 hours time is adequate for a batch cooking, when compared to 9–10 hours for normal hardwoods (Bluegum and Wattle). Cooking conditions and properties of unbleached pulp are presented in Table–V and Table–VI. Unbleached pulp analysis compare well with regular unbleached pulp produced from Eucalyptus globulus and wattle. (Table–VII)

Unbleached pulp from cook No III having comparatively higher viscosity and lower sieber number was selected for bleaching and bleached in normal C—E—H sequence. Bleaching conditions are shown in the Table–VIII. Bleach chemical consumption and bleaching shrinkage is more in case of partially depithed bagasse pulp since siber number of pulp is bigh and alkali solubles are more. Due to higher pentosan and

TABLE—III

Fractional analyses of bagasse

Sl. No.	Particulars	Unit	Whole Bagasse	Depithed Bagasse	Pith
1.	Ash	%	1.8–2.2	1.2–2.2	2.6–6.3
2	1% NaOH solubiliy	%	27.0–33.0	26 8–31.2	30 3–36.2
3.	Alcohol-Benzene Extract	%	3.2–10.8	2.0–3.6	2.1–2.9
4.	Hot water solubility	%	2.8–11.2	1.4–4.5	1.5–4.6
5.	Pentosans	%	27.7–31.8	30.7–32.5	30.7–33.2
6.	Lignin	%	18.1–22.3	19.1–21.8	18.0–22.5
7.	C & B Cellulose	%	50.2–56.8	56.0–62 9	52.5–55.4
8.	Alpha Cellulose	%	30.1–34.9	36.7–41.2	30.6–34.9

TABLE—IV

Analyses of regular hard woods

(by the Procedure of W.H. Dore)

Sl. No.	Analysis Particulars	Eucalyptus Globulus	Wattle	Norms
1.	Moisture %	25–30	25–30	30
2.	Basic Density (gm/cc)	0.55–0.65	0.6–0.7	0.60
3.	Benzene Extract %	0.22–0.40	0.2–0.40	0.50
4.	Alcohol Extract %	0.5–3 0	2.5–4.0	2.50
5.	Cold Water Extract %	0.5–2.0	0.5–2.0	1.20
6.	5% NaOH Extract %	5.0–8.0	5.0–7.5	5.00
7.	Pentosans %	19.0–23.0	23.0–27.5	20.00
8.	Lignin %	25.0–28.0	22.0–25.0	30.00
9.	C & B Cellulose (By DIF) %	40.0–42.0	40.0–42.0	40.50
10.	Ash %	0.1–0.30	0.1–0.30	0.30
11.	Acid insolubles %	—	—	—
12.	CaO %	0.03–0.10	0.12–0.27	0.05

TABLE—V

Cooking Experiment Datail

Sl. No.	Cook No.	Total cooking time hrs.	Time to reach Max. temp.	Cooking time at max. time & pressure	Maximum temp.	Minimum pressure Kg./cm2
1	Cook No. I	3	2	1	138	8
2	Cook No. II	4 1/2	2 1/2	2	140	8
3	Cook No. III	5 1/2	2 1/2	3	141	8
4	Vat cook in Plant Digester (Basket cooking)	10	7	3	140	8

hemicellulose contents of bagasse pulp caustic requirement of extraction stage is high. Bleached pulp sample was analysed for basic characteristic of dissolving grade pulp and results are compared in Table IX with SIVIL regular pulp.

Discussion :

Though encouraging results are obtained from the study the sieber number values are on higher side which can be brought down by improved cooking conditions like increased SO_2 content in cooking liquor, increased retention time at maximum temperature and pressure or pre steaming prior to cooking etc. This will help in maximum removal of lignin and pentosans in the cooking stage itself so that chemical consumption in bleaching stages will come down. Calcium content of 140 ppm in bleached pulp (partially depithed bagasse pulp) is within acceptable limits for dissolving grade pulp. Total ash content in Pulp (12000 ppm) as shown in table-IX is very high for dissolving grade pulp. Pith and dirt with bagasse are major contributors of ash content. Efficient wet depithing and pre and post bleaching centricleaning of pulp will reduce the ash content to desired levels. Strength property (viscosity), brightness of pulp, alpha cellulose content, beta and gamma cellulose, S10, S18 solubilities etc. are the basic characteristics of dissolving grade pulp. A comparison with standard values suggest that the pulp is suitable for staple fibre manufacture after further removal of impurities like ash content, silica, pentosans resins, etc.

TABLE—VI
Cooked Pulp Characteristics

Sl. No.	Cook No.	Sieber Number	Viscosity (Snia)	Alpha Cellulose	Pentosans	Ash PPM	CaO PPM
1	Cook No. I	>80	31	70.41	19.27	20460	4312
2	Cook No. II	>80	41	75.60	8.51	54900	14672
3	Cook No. III	73	52	78.9	11.3	35720	9016
4	Vat cook in Plant Digester (Basket cooking)	73	24	85.80	7.98	30860	8176

TABLE—VII
Unbleached Pulp Characteristics

Sl. No.	Properties	Units	Regular SIVIL Pulp	Partially Depithed Bagasse pulp
1	Viscosity (SNIA)	Cp	30—60	25—50
2	Sieber Number	No.	17—21	64—130
3	Alpha Cellulose	%	88—89.5	70—86
4	Pentosans	%	6—7	8—19
5	Ash	ppm	4000—8000	20000—55000
6	CaO	ppm	2000—4000	4300—14600
7	Resin content	%	0.4—0.6	1.3—1.9
8	Yield	%	46—47	45 - 46

TABLE—VIII
Bleaching Sequence Details

Sl. No.	Particulars	Unit	Regular SIVIL Pulp	Partially depithed Bagasse Pulp
1	Chlorination	%	2.0	5 0
2	Alkali Extraction	%	4.0	8.0
3	Hypo (Sodium hypochlorite) at 3 2% active chlorine	Ltrs/tonne OD	300-320	320
4	Bleaching shrinkage	%	8-10	25.36
5	A.D. Pulp yield	Kg/Kg.	0.425	0.30

TABLE—IX

Bleached Pulp Analysis Results

Sl. No.	Charcters analysed for	Unit	Regular SIVIL Pulp	Pulp from depithed bagasse
1	Viscosity (SNIA)	Cp	27—33	15—23
2	Alpha Cellulose	%	90.5—91.5	90.0
3	Beta Cellulose	%	5.0—6.0	8 0
4	Gamma Cellulose	%	3.0—4.0	2.0
5	S 10 Solubi ity	%	10—11	12.32
6	S 18 Solubility	%	5—6	5.84
7	Pentosans	%	3 5—4.5	6.35
8	Resins	%	0.25—0.35	0.58
9	Brightness Photovolt	%	90—91	86—87
10	Ash	ppm	350—600	12000
11	CaO	ppm	100—250	140
12	Yield (Rayon yield calculated baased on S 10 & S 18 values)	%	94—95.5	94 30

Conclusion :

The average fibre length, strength, bleachability suggest that depithed bagasse is a potential raw material for dissolving grade pulp. Lower lignin content of bagasse is an advantage to reduce cooking time. Higher ash content, pentosans, hemicelluloses are the bottlenecks at present which must be overcome by further developments. Since bagasse is a bulky raw material, technical developments are needed in this area to handle this material. Pandia type continuous digester for acid sulphite pulping in future studies may prove economical, efficient and continuous method of cooking.

Inherent strength of fibre is greatly affected in crushing operation in sugar mills. Some Developments are required in these areas so that available bagasse would have more undamaged fibres.

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