Bagasse vis-a-vis Hardwood (E. hybrid) for Papermaking

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ABSTRACT

TNPL utilises both Bagasse and Hardwood for the manufacture of Newsprint and Printing & Writing grades of paper. Eucalyptus hybrid pulp and Bagasse pulp are used in the ratio 25:75. The behavior of bagasse pulp in comparison to eucalyptus hybrid pulp was studied. Bagasse produces a brighter pulp with lower kappa number. The bleachability of bagasse chemical pulp is very good. Bagasse pulp possesses better bonding properties and a lower tear. The bulk and Scattering coefficient of chemical bagasse pulp is low resulting in lower opacity and higher show through. The wet web strength of bagasse pulp is similar to those of eucalyptus hybrid pulp.

Introduction :

Tamilnadu Newsprint and Papers Ltd. is a bagasse-based integrated paper mill with a capacity of producing 50,000 tons of Newsprint and 40,000 tons of Printing and Writing grades of paper. 75% of the paper furnish comprises of bagasse pulp, the rest being Eucalyptus hardwood pulp or chemical pulps of other locally available hardwood varieties like Karuvelam, Wattle and Grandis. Both chemical and mechanical pulps are produced from bagasse and only chemical pulp is produced from Hardwood. About 3,00,000 tonnes of bagasse is being consumed annually for manufacture of Newsprint and printing and writing grades.

Bagasse has emerged out as the main alternative for papermaking for future. In the recent years, the dependence on bagasse has increased, with the fast depletion of forest wood resources. To cope up with the wood shortage, the established mills are going in for bagasse as their major raw material for paper making.

This paper highlights how bagasse behaves differently from Eucalyptus hybrid, and also the differences between chemical bagasse pulp and eucalyptus hardwood pulp with respect to their Physical, Strength, Optical, Printability and Ink absorbancy characteristics.

Bagasse in Comparison to Eucalyptus Hybrid :

Bagasse, unlike hardwood varieties, has an open structure. With a moisture content varying between 50—55%, bagasse is composed of 50—60% useful fibre, 33—36% pith and the remaining dust and solubles. The pith content, which is not desirable for papermaking, is removed to the maximum possible extent by depithing. Bagasse received only during the crushing season, is depithed and stored in an open yard for further utilisation throughout the year.

Bagasse possesses a very low bulk density of 50—60kg/m³, on OD basis, as against 180—220-kg/m³, for eucalyptus hardwood. This is in support of the fact that bagasse requires very large space for storing when compared to hardwood. Among various storage methods adopted, the WET BULK STORAGE method facilitates maximum bagasse storage in minimum area. With a bulk density due to compaction reaching 150 kg/m³, bagasse is stored at a moisture

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content of 75% in piles reaching a height of 10—12 metres. This high moisture and the presence of residual sugars and the open nature of bagasse lead to discoloration and deterioration of bagasse upon storage, which is not also uniform throughout a pile. This deterioration and discoloration of bagasse has been attributed to the action of micro organisms. This discoloration of bagasse is serious as far as the mechanical pulping is considered since the mechanical pulp produced out of it is dark and not easy to bleach economically to acceptable brightness level.

Whereas, Eucalyptus Hybrid, by virtue of its higher basic density than bagasse (550 kg/m³ against 230 kg/m³ for bagasse), is not easily prone to degradation and decay to the extent that bagasse undergoes. The presence of sugar and moisture in bagasse further accelerate the discoloration and degradation. Hardwood does not pose such problems on storage.

Chemical Composition :

Chemically, bagasse is similar to Eucalyptus hybrid. The proximate chemical analysis of bagasse and Eucalyptus Hybrid are given in Table 1. The results show that bagasse possesses lower Lignin content. The Hot water solubility, 1% Caustic solubility and the pentosans are on the higher side for bagasse. The holocellulose content is almost similar in both the cases.

TABLE 1

Proximate Analysis of Bagasse and Eucalyptus Hybrid

SlNo.	Particulars	Unit	Depithed Bagasse	Eucalyptus Hybrid
1	Ash	%	1.3	0.5
2	Silica	%	1 1	0.2
3	Solubility in :			
	Hot water	%	4.0	2.5
	Alcohol Benzene	%	2.8	2 0
	1% Sodium Hydroxide	%	32.0	17.0
4	Lignin	%	21.0	28.0
5	Holocellulose	%	69.0	67.0
6	Pentosans	%	23.0	17.0

Pulping :

Because of its open nature, bagasse requires lesser chemicals for pulping than eucalyptus hybrid. The pulping data for bagasse in comparison to eucalyptus hybrid, for chemical pulp production, is given in Table 2. Bagasse produces a softer pulp with lower Kappa Number and higher brightness even with lower chemicals. The bulky nature of bagasse necessitates higher bath ratio of 1:4 for pulping as against 1:2.8 for hardwood. The cooking time required is also low and the total pulp yield is high. The residual active alkali of bagasse black liquor is higher than that of eucalyptus hardwood black liquor.

Bleaching :

In comparison to hardwoods and softwoods, the bagasse fibre properly depithed is easy bleach.(1). Very high ultimate brightness can be achieved even with very low bleach chemicals. The bleaching sequence employed is C-E-H. Because of the low initial Kappa number, the chlorine demand in chlorination is low in comparison to that of euca hybrid. The bleaching losses are also low and the brightness stability as shown by the post color number is high for chemical bagasse pulp. On the contrary. Euca hybrid is bleached by C-E-H-H sequence and attaining high brightness is very difficult. The post color number is also high (4.7 against 2.4 for chemical bagasse). The bleaching data for bagasse and hardwood are given in Table 3.

Pulp Properties :

Strength properties :

Strength properties of chemical bagasse pulp are almost similar to those of eucalyptus hardwood pulps except tear index, which is slightly on the lower side for begasse pulp.

Tropical hardwood species of high density produce a paper sheet with imbalanced tear and tensile. The pulps have satisfactory tearing resistance but are slightly inferior in tensile and other bonding properties.(2) On the other hand, bagasse pulps have lower tearing resistance and acceptable breaking length. The strength properties of chemical bagasse and refined eucalyptus hardwood pulp are given in Table 4. The results show though bagasse pulp possesses satisfactory tearing strength, it is comparatively lower than that of euca-

TABLE 2

PULPING DATA

SL No.	Particulars	Unit	Depithed Bagasse	Eucalyptus Hybrid
1.	Cooking chemicals	%	12.0	15.0
2.	Cooking temperature	°C	170	170
3	Cooking time	min	20	90
4.	Bath ratio		1 : 4	1 : 2.8
5.	H factor		450	1600
6.	Total yield	%	55—57	44—45
7.	Screen rejects (0.15 mm)	%	0.7—1.2	0.3—0.4
8.	Kappa number		10—12	22—24
9.	Unbleached pulp Brightness	% ISO	40—45	24—28
10.	Black liquor :			
	PH		11.5—12.0	11.0—12.0
	*TTA as Na_2O	g/l	28—30	32—34
	*RAA as Na_2O	g/l	4.5—6.0	2.0—4.0

* 200 g/l total solids

TABLE 3

Bleaching Data For Bagasse And Euca Hybrid Pulps

SL No.	Particulars	Unit	Bagasse Pulp	Euca Hybrid Pulp
1.	Unbleached pulp Kappa No		10—12	22—24
2.	Chlorine as Cl_2 % in chlorination	%	1.7—2.0	3.5—4.0
3.	Caustic as NaOH in Extraction	%	1.0	2.0
4.	Hypochlorite as Cl_2 in Hypo I stage	%	0 4—0.6	2.0—3 0
5.	Hypochlorite as Cl_2 in Hypo II stage	%	—	1.0
6.	Final brightness	% ISO	80—84	76—78
7.	Bleaching losses (on unbleached pulp)	%	3.0—4.0	6 0—7.0

TABLE 4

Strength Properties of Bagasse Pulp And Euca Hybrid Pulp

SL No.	PARTICULARS	UNIT	BAGASSE PULP	REFINED EUCA HYBRID PULP
1	Freeness	ml CSF	450	410
2	Bulk	CC/G	1.55	1.73
3	Breaking length	Metres	6720	7230
4	Tear factor		57	74
5	Burst factor		41	45
6	Brightness	% ISO	79	73
7	Opacity (ptg)	%	76	85
8	Scattering Coefficient	m^2/kg	32	47
9	Yellowness	%	8	16
10	Fibre classification			
	+30	%	6.8	0.8
	−30 +50	%	33.8	59.2
	−50 +100	%	20.9	15.2
	−100 +200	%	21.3	9.8
	−200	%	17.2	15.2
11	Initial wet web tensile index @ 25% solids	Nm/g	0.9	0.9

lyptus hybrid pulp. The initial wet web tensile index of chemical bagasse and other bonding properties are similar to hardwood pulp.

Optical characteristics :

The optical properties of the unbleached pulps are given in Table 5. The brightness of the bagasse pulp is higher than that of hardwood pulp. Other factors like Scattering coefficient and yellowness are lower for chemical bagasse. The great weakness of bagasse pulp is its low scatering Power. The scattering coefficient of bagasse pulp does not reach interesting levels, whatever be the pulping process adopted. (3). Bagasse pulps produce a sheet of lower bulk and lower opacity. The lower value of Absorption coefficient and Scattering coefficient result in a bagasse pulp sheet of lower opacity in comparison to eucalyptus hardwood. (4)

The Optical properties of the bleached pulps given in table 6 also follow a similar trend. The Absorption coefficient, Scattering coefficient and yellowness of bleached bagasse pulp are also lower than the corresponding values of eucalyptus hardwood pulp. Because of this nature, at the same brightness level, bagasse pulp possesses lower opacity than eucalyptus hardwood (fig 1).

FIGURE 1

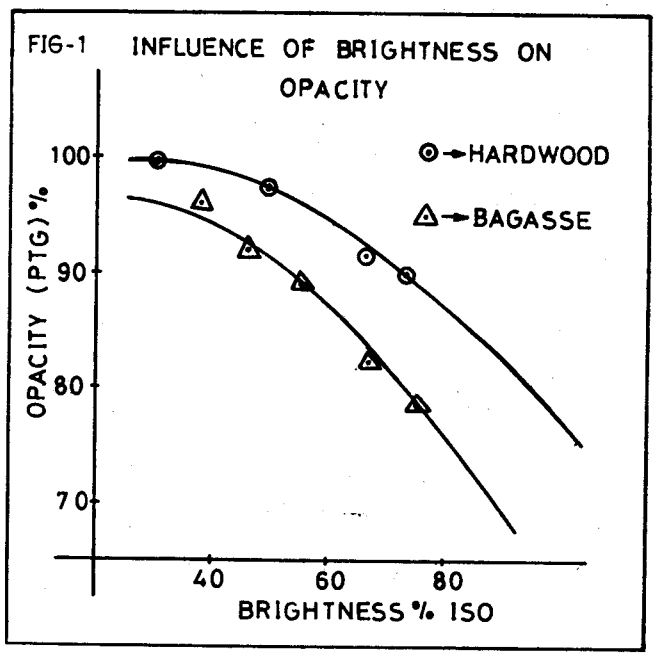


TABLE 5

Optical Properties Of Unbleached Pulps

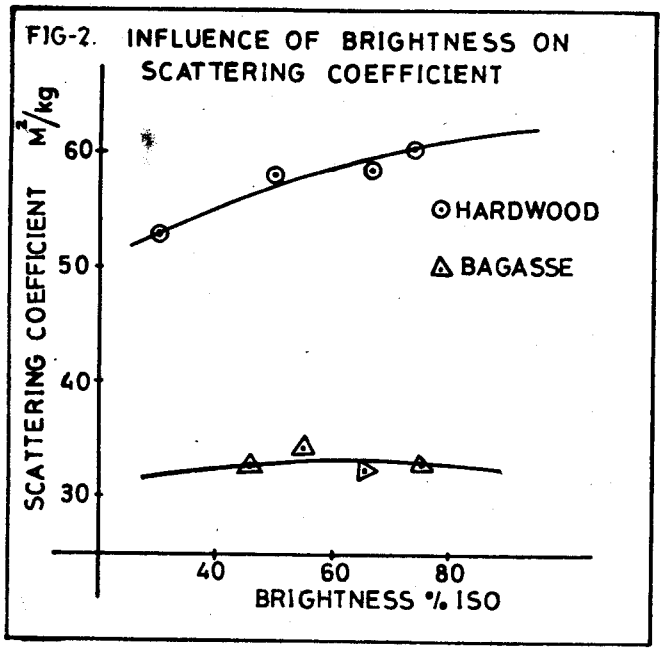
SLNO.	PARTICULARS	UNIT	DEPITHED BAGASSE	EUCALYPTUS HYBRID
1	Brightness	% ISO	40—45	24—28
2	Opacity (ptg)	%	89—92	97—99
3	Scattering Coefficient	m^2/kg	30—35	35—40
4	Absorption Coefficient	m^2/kg	4.0—6.0	18—23
5	Yellowness	%	26—28	34—36

TABLE 6

Optical Properties of Bleached Pulps

SLNO	PARTICULARS	UNIT	DEPITHED BAGASSE	EUCALYPTUS HYBRID
1	Brightness	% ISO	80—84	76—78
2	Opacity (ptg)	%	75—78	85—90
3	Scattering Coefficient	m_2/kg	30—35	50—55
4	Absorption Coefficient	m^2/kg	0.2—0.5	0.8—1.2
5	Yellowness	%	6-9	15—18

Another interesting feature observed is, upon bleaching, the scattering coefficient of eucalyptus hardwood pulp improves from 28 to 55 m^2/kg Whereas the scattering coefficient of bagasse pulp remains unaltered. (fig 2). This may be due to the high initial brightness of chemical bagasse pulp where the scattering coefficient has already reached maximum level.



The changes in optical characteristics across the bleaching sequence is given in Table 7. It may be noted from the table that the improvement of scattering coefficient reaches a maximum at the chlorination stage itself, in the case of eucalyptus hybrid and very less improvement is observed in the ensuing stages. In the case of bagasse pulp, improvement is not observed.

So from the optical properties, it is evident that bagasse possesses lower absorption coefficient, scattering coefficient and yellowness, resulting in lower Opacity than hardwood eucalyptus hybrid pulp. This is one of the major inherent drawback of bagasse pulp.

Printability and Absorbancy Characteristics :

The printability of paper is influenced by the optical and absorabancy characteristics of the pulp furnish, The low scattering coefficient of bagasse also affects the printability becasue of lower opacity which tends to result in higher print show through.

The printability and ink absorbancy characteristics of hardwood and bagasse pulps are given in Table 8. The porosity of chemical bagasse pulp is very low when compared to that of euca hybrid pulp which directly influences the ink absorbancy. and oil absorbancy. The oil absorbancy is very low for bagasse pulp so also the ink absorbancy, as shown by the K&N number.

Though bagasse pulp possesses low oil absorbancy, the show through and strike through properties are higher for bagasse, wh ich may be attributed to its low bulk and low scattering coefficient.

The cobb value of bagasse pulp is higher than that of ecualyptus hardwood which shows that bagasse fibres are more hydrophilic than hardwood fibres. Achieving low cobb value with bagasse pulp is a bit difficult.

TABLE—7

Changes in Optical Characteristics Across The Bleaching Sequence

Sl. No. Particulars	Unit	Depithed Bagasse				Eucalyptus Hybrid			
		Ubld	C	E	H	Ubld	C	E	H_2
1. Brightness	% ISO	47.0	49.0	55.0	83.0	28.0	38.0	41.0	77.0
2. Opacity (ptg)	%	94.0	93.2	89.8	76.0	99.5	98.8	98.8	87.0
3. Scattering Coefficient	m^2/Kg	34.2	34.9	34.8	35.2	37.6	50.4	53.3	55.4
4. Absorption Coefficient	m^2/Kg	5.0	4.5	3.2	0.3	20.6	11.5	10.4	0.6
5. Yellowness	%	27.1	27.3	23.4	7.8	35.3	37.7	35.0	15.6

Ubld—Unbleached : C—chlorinated Pulp : E—Extracted pulp
H—Hypo bleached pulp

Other Aspects :

The physical characteritics of bagasse and hardwood pulps are given in Table 9. Bagasse pulps possess higher shrinkage. The CED viscosity of bagasse pulp is higher than that of eucalyptus hardwood pulp. The drainage time of chemical bagasse pulp is slightly higher than that of hardwood pulp.

Refining of eucalyptus hybrid pulp results in improved bonding strength and improved tear with reduction in the optical characteristics, while refining bagasse results in drop in tear with slight improvement in bonding properties. The refining energy requirement of bagasse pulp is very low when compared to refining of eucalyptus hardwood pulp.

Observations and conclusions :

1. Bagasse pulp possesses better bonding properties and lower tear compared to hardwood pulp.
2. The unbleached brightness of bagasse pulp is high and it is easily bleachable.
3. Bagasse pulp possesses low bulk and low Scattering and absorption coefficient resulting in lower opacity and higher show throughness.
4. The ink absorbancy of bagasse pulp is low.
5. Water absorbancy of bagasse pulp is higher than that of eucalyptus hybrid pulp.
6. Shrinkage of bagasse pulp is higher than hardwood pulp.
7. Initial wet web tensile index of chemical bagasse and hardwood pulps are similar.

TABLE—8

Printability And ink Absorbancy Characteristics of Bagasse & Eucalyptus Hybrid Pulps

SLNo.	Particulars	Units	Chemical Unsized	Bagasse Sized	Eucalyptus Unsized	Hybrid Sized
1.	Brightness	% ISO	76 0	76.1	73.0	73.4
2.	Opacity (ptg)	%	76.9	78.2	87.8	88.8
3.	Scattering Coefficient	m^2/Kg	31.3	33.6	53.5	57.1
4.	Yellowness	%	9.8	11.0	15.9	15.7
5.	Smoothness	ml/min	90	110	260	220
6.	Roughness	microns	3.0	3.2	4.7	4.6
7.	Porosity	ml/min	125	220	2500	2400
8.	Cobb	g/m^2	—	25	—	14
9.	Oil absorptivity	g/m^2	14	24	63	67
10.	K&N number	No	52.1	54.2	78.1	79 1
11.	Print quality	%	86.5	86.2	88.4	88.4
12.	Show through	%	30.6	27.2	13.3	13.9
13.	Strike through	%	26.5	23.4	11.8	12 3
14.	Print density	D	0 93	0.92	0.97	0.98

TABLE 9

Physical Characteristics of Bagasse And E. Hybrid Pulps

SLNO	PARTICULARS	UNIT	BAGASSE PULP	EUCALYPTUS HYBRID PULP
1	Shrinkage	%	5.3	4.3
2	Post color number (105 C 4 Hrs)		2.4	4.7
3	CED viscosity	CPS	13—16	4—6
4	Drainage time @ 20 'C 60 gsm	SEC	5.0-6.0	4.5—5.0

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