Characteristics of Bagasse Based Paper and Pulp

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This mill happens to be the only mill in South Asia, where bagasse is used as a major raw material for papermaking, and where more than two thousand tonnes of different grades of writing and printing papers have been made out of 100% bagasses fibre. During the last six months it has been possible to maintain the furnish with 90% bagasse fibre in all grades of papers with a basic weight of 60 gms/m² and above. In lightweight papers like manifold or 33-25 gms/m² basis weight range, the bagasse fibre content has been between 50% to 70% in the furnish. It is gratifying to note that most of our brands are very highly acclaimed by the consumer market of this country for their qualities like high brightness, high strength, non-reversion of shade, good feel and good printing and writing properties.

Given below is a brief account of the characteristics of bagasse used in the process and also of the resulting pulp and paper having 100% and high bagasse fibre contents in the furnish.

Characteristics of Bagasse :

As designed, the paper mill gets its bagasse from the Mysore Sugar Company, Mandya, after initial depithing by horkel depithers there. Due to reasons beyond control, when bagasse supply from Mandya is poor, it has to obtain bagasse from other sources which is undepithed and sometimes in loose form. Undepithed bagasse is brought from a nearby sugar factory at Pandavapura.

Fibre and chemical characteristics of both of these varieties of bagasse are given below in Table No. 1 :

TABLE 1

FIBRE AND CHEMICAL CHARACTERISTICS OF RAW AND DEPITHED BAGASSE

Sl. No.	Particulars	Mandya Bagasse		Pandavapura
		Whole Bagasse	Horkel depithed bagasse	Whole Bagasse
		% W/W	% W/W	% W/W
1.	Moisture	52.0	—	47.8
2.	Ash	2.1	—	1.9
3	Solubility in hot water	18.1	—	17.0
4.	Solubility in 1% NaOH	28.0	—	27.0
5.	Solubility in Alc. Benzene	1.1	—	0.8
6.	Total sugars (as d-glucose)	2.4	—	2.1
7.	Pentosans	23.9	—	24.1
8.	Lignin	18.8	—	20.5
9.	C&B— Cellulose	55.2	—	53.2
10.	Useful fibre	53.2	68.8	58.3
11.	Pith and fines	32.6	19.0	31.7
12.	Solubles, colloidal matter and dust.	14.2	12.2	10.0
13.	Fibre/Pith ratio	100 : 61.2	100 : 27.6	100 : 54.4
14.	Fibre/solubles ratio	100 : 26.6	100 : 17.7	100 : 17.15

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Though the species of sugarcane are nearly same and they grow in close neighbourhood of each other, the chemical components in bagasse from these two sources are slightly different due to variation in crushing conditions in respective mills.

From the fibre/pith data given in Table no. 2, it will be evident that considerable amount of solubles, colloidal matter and dust get removed in the preliminary treatment of bagasse in hydrapulper, Rietz and the feeder screw. Rietz operation helps in removing a sizeable portion of pith and fines. Fibrous portion is markedly enriched, and at the same time bagasse bundles open up which helps in quick cooking operation.

TABLE 2

FIBRE/PITH CONTENT OF BAGASSE ENTERING PANDIA DIGESTER

Sl. No.	Particulars	Depithed bagasse after Rietz % W/M	Squeezed bagasse entering Pandia % W/M
1.	Moisture	82.2	58
2.	Fibre	69.3	79.2
3.	Pith and fines	18.3	18.2
4.	Solubles, colloidal matter and dust	12.4	2.6
5.	Fibre/Pith ratio	100 : 26.4	100 : 23
6.	Fibre/solubles ratio	100 : 17.9	100 : 3.28

The fibre to pith ratio falls down from 100 : 61.2 in raw bagasse to 100 : 23 in the final stuff going to digester. Removal of dust, solubles and colloidal matter in the existing two-stage operation of depithing is more than 85% as the ratio of fibre to solubles falls from 100 : 26.60 to 100 : 3.28 from raw bagasse to finally treated bagasse.

It has been observed that whenever whole bagasse is used, instead of depithed bagasse, the relative values of fibre/pith and fibre/solubles also go higher than noted above.

Characteristics of Bagasse Pulp:

From some of the variation is cooking conditions in Pandia digester, changes in bagasse pulp characteristics are given in Table no. 3 below.

TABLE 3

PULPING VARIABLES AND PULP CHARACTERISTICS

Sl. No.	Particulars	CONDITIONS IN SET NOS. I	II	III	IV
1.	Cooking Press lbs/p.s.i.	110	110	100	100
2.	Equivalent steam temp. °C	168	168	164	164
3.	Total retention time in digester— in minutes	10	12	12	14
4.	Bath ratio in digester	1 :3.5	1 :3.5	1 :3.5	1 :3.5
5.	% NaOH (used on b.d. bagasse)	13.5	16.0	14-15	17-18
6.	$KMnO_4$ No. of unbleached pulp	10.5	9.5	9-9.5	8.7-9
7.	Freeness of unbleached pulp —°SR	22	24	22-23	23-24
8.	Average free alkali in thin black liquor (NaOH gpl)	8.5	8.0	8.0	9.0
9.	Remarks	Rejects more	Washing deterioration	Best washing. Lease rejects.	Foaming tendency washing not good.

Fibre and chemical characteristics of the normal bagasse pulp made under conditions stated in Col. III of Table no. 3 have been found to be as follows;

TABLE 4

CHEMICAL CHARACTERISTICS OF NORMAL BAGASSE PULP FROM PANDIA

Sl. No.	Particulars	Unbleached bagasse Pulp (Ref. Col. III Table no. 3)	(LABORATORY) Bleached bagasse pulp (Ref. Table no. 5)
1.	Permanganate no.	9.5	—
2.	Brightness—°GE	55	84
3.	Freeness—°SR	21	23
4.	1% NaOH—solubility	6.0	11.4
5.	Pentosans—%	22.3	22.6
6.	Cu. No.	0.51	0.83
7.	Viscosity, cp (TAPPI)	80.0	40.0
8.	Cellulose %	74.8	77.0
9.	Lignin— %	6.7	—
10.	Ash—%	0.80	0.5
11.	Fibre classification (Bauer McNett) (% W/W)		
	÷20 mesh	0.30	0.10
	÷35 mesh	13.60	22.10
	÷48 mesh	16.50	17.40
	÷100 mseh	40.10	31.40
	—100 mesh	29.50	28.10
12.	Fibre length (mm)	1.525 (Max. 2.116) (Min. 0.949)	—
	Fibre dia. (mm)	0.0261 (Max. 0.0438) (Min. 0.0219)	—

This pulp was bleached in the laboratory employing chlorination-caustic extraction—hypo sequence.

In laboratory bleaching test with unbleached bagasse pulp (of Table no. 4), a total chlorine consumption of 3.9% was found in 3-stage operation to get a brightness of 80°GE, against a total chlorine consumption of 3.5 to 4% for 85°GE brightness in the plant under normal · perating conditions. Strength properties of this pulp, both bleached and unbleached beaten in a standard valley beater are given in

TABLE 5

BLEACHABILITY OF BAGASSE PULP

Sl. No.	Conditions of Bleaching	Stage I Chlorination	Stage II Caustic Extraction	Stage III Hypo-Treatment
1.	$KMnO_4$ No.	9.5	—	—
2.	Consistency–1%	3.5	12	12
3.	Temp.—°C	30	55-60	50-55
4.	pH	2.0	11-11.5	9-9.5
5.	Chemical consumed (% on b.d. pulp)	2.0 (as cl_2)	1.2 (as NaOH)	1.2 (as cl_2)
6.	Total time (hours)	1.0	1.5	2.0

Table no. 6. These data with standard handsheets of 60 gms. weight c'early establish the high quality of bagasse pulp cooked in Pandia digester under conditions stated in Column III of Table no. 3.

TABLE 6

STRENGTH PROPERTIES OF STANDARD HANDSHEETS OF 100% BAGASSE PULP

Sl. No.	Properties	Unbleached pulp	Bleached pulp
1.	Initial freeness—°SR	21.0	22.0
2.	Time taken to develop 45° SR in std. valley beater (min)	14.0	15.0
3.	Basis weight gm/m²	60.3	62.0
4.	Burst factor	49.36	41.0
5.	Tear Factor	71.6	69.7
6.	Breaking length (m)	5858	4700
7.	Folding endurance (double fold nos.) (Schopper)	291	175

The coniferous wood sulphite unbleached pulp imported from U.S.S.R. has a permanganate no. of

TABLE

STRENGTH PROPERTIES

Sl. No.	Quality	FURNISH		Basis wt. gm/m²	Caliper (Micron)	BURSTING STRENGTH		
		Bagasse	Sulphite wood			BULK	Burst Strength kg/m²	Burst factor
1.	White Ptg.	100	—	48	70	1.37	—	22
2.	,,	100	—	52	72	1.4	—	22
3.	,,	100	—	62	86	1.38	—	23.1
4.	,,	100	—	60	79.8	1.41	0.99	17.3
5.	Duplicating SA	100	—	71	120	1.69	—	24.6
6.	,,	100	—	75	119	1.58	—	24.5
7.	,,	100	—	75	107	1.52	1.2	17.68
8.	White Ptg.	100	—	67	97.8	1.61	1.06	17.32
9.	Cartridge	50	50	130	200	1.584	2.375	18.81
10.	,,	90	10	130	198	1.549	1.88	14.71
11.	,,	50	50	110	179	1.68	2.28	21.32
12.	,,	90	10	110	153	1.52	2.31	23
13.	Creamwove	70	30	60	73	1.21	0.94	15.9
14.	,,	70	30	60	72	1.35	1.10	20.6
15.	White Ptg.	90	10	60	82	1.47	1.01	18.1
16.	Duplicating SA	80	20	75	119	1.71	1.04	14.74
17.	,,	80	20	75	115	1.48	1.05	13.6
18.	Maplitho	70	30	82	87	1.18	1.04	13.92
19.	,,	70	30	72	80	1.25	1.21	19.22
20.	Newsprint (semi-bleached)	90	10	54	75.3	1.43	1.16	22.35
21.	Typewriting	70	30	40	60	1.53	0.90	23.72
22.	Manifold	70	30	33	52	1.56	0.31	22.2

about 14.0, freeness of 10° SR and 62° GE brightness. It is found to blend very well in desired proportions from 10 to 50% with the aforesaid unbleached bagasse pulp, and no difficulty is experienced in bleaching such blended stocks in 3-stage bleaching operation as given in Table no 5.

Characteristics of Paper:

General characteristics and strength properties of paper made out of 100% bagasse and high bagasse furnish, are found to be very good and of high order. In Table no. 7 above, strength properties of papers of different basis weights and of varying furnishes from 100% bagasse to 50% bagasse and 50% sulphite wood pulp have been given. This data proves beyond boubt the suitability of bagasse fibre for the manufacture of any variety of paper with and without the use of fillers.

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OF BAGASSE PAPER

TENSILE STRENGTH KG.				TEARING STRENGTH				FOLDING ENDURANCE (MIT)			
M.D. Kg.	C.D. Kg.	Mean Kg.	Breaking length (m)	M.D. gm.	C.D. gm.	Mean gm.	TEAR FACTOR	M.D. (DF)	C.D. (DF)	MEAN (DF)	Ash%
3.3	1.8	2.55	3534	26	30	28	58.3	9	5	7	1.1
3.34	2.42	2.88	3675	30	36	33	63.5	22	10	10	1.07
4.68	2.5	3.59	3860	30	40	35	56.5	18	7	12.5	1.6
3.28	2.1	2.72	3061	26.25	30.6	28.45	49.46	8	4	6	12.04
5.9	3.5	4.7	4296	40	48	44	61.8	41	16	28.5	1.5
5.8	3.85	4.82	4280	52	60	56	74.7	55	23	39	1.3
3.76	2.76	3.26	3123	32.8	34	33.4	47.93	8	6	7	14.1
3.49	2.63	3.06	3387	32	32	32	50.48	8	5	6.5	9.57
8.9	5.68	7.29	3851	80	104	92	72.9	55	22	38.5	4.0
7.18	4.5	5.84	3046	72	84	78	61.02	28	15	21.5	9.43
9.66	5.35	7.53	4719	68	81	76	70.5	39	16	27.5	0.6
7.92	5.05	6.48	4330	61.1	68.8	65.4	65.1	37	19	28	6.0
3.20	2.18	2.56	2942	24	28	26	42	7	4	5.5	19.7
4.7	2.0	3.35	4151	28	30	29	53	12	6	9	13.4
3.92	2.51	3.09	3707	31	35	33	59.15	10	7	8.5	12.7
3.27	2.14	2.7	2680	40	48	44	59.1	8	5	6.5	14.4
4.7	2.6	3.65	3166	42	46	44	57	7	3	5	25.9
4.41	3.6	4.0	3236	31	32	31.5	42.1	5	5	5	20.1
4.47	2.68	3.58	3722	29.0	31	30	47.4	9	6	7.5	14.83
3.77	2.19	2.98	3798	28.9	32.5	30.8	58.2	16	8	12	6.8
3.08	1.72	2.4	4331	78.5	21.5	20	53	10	4	7	0.8
2.28	1.8	2.04	3893	18	20	19	57	7	4	5.5	0.56

Conclusion :

From a survey of discussions and the data of strength properties and other characteristics of pulp and paper from 100% and high furnish bagasse described above, a conclusion may be safely drawn on the suitability of bagasse fibre for making any variety of paper of any basis weight. We have found with the existing technological facilities available to run successfully a 33 gms paper with 70% bagasse fibre at speeds of 180 m/min. If the drainage characteristics of bagasse pulp can be improved with the use of suitable synthetic resins or celite-like material, perhaps tissue papers of much lighter weights can be successfully made at high speed.