Utilisation of Bamboo Dust (Part-II)

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SUMMARY

The study indicates that about 50 percent of the chipper reject having particle size over 0.4 mm. could be used for pulp manufacture satisfactorily. For the manufacture of paper grade pulp about 20 percent alkali was required on the weight of dust giving 39 percent yield of unbleached pulp. The pulp could satisfactorily be bleached with 10 percent total chlorine giving an yield of about 36 percent which is only slightly lower than that from normal bamboo chips. The strength properties of laboratory hand sheets were quite comparable with those made from normal bamboo pulp except that the tear factor was slightly lower. This fraction could alternatively be used for making pulp for mill board by digestion at atmospheric pressure with 15 percent caustic soda under conditions that about 8 percent alkali was consumed. The remaining alkali in black liquor could be recycled. The yield of pulp was around 65 percent. The remaining 50 percent of the dust could be used for making particle board for room partitions, table tops etc. using urea formaldehyde resin as binder.

INTRODUCTION

Bamboo chipper rejects, popularly known as bamboo dust, has almost the same chemical composition as the bamboo chips. The dust is always separated from the chips to maintain uniform size in the digester charge. The screen rejects may amount upto about 5 per cent of the total bamboo chipped. The utilisation of this dust will not only give added benefits to the paper mills but will solve the problems of fire hazard and disposal etc. of this material. Bamboo dust was collected from the Chipper House of M/s. Rohtas Industries Ltd. Dalmianagar (Bihar).

METHOD

The screen analysis of the dust was first carried out and was as follows :—

Mesh No.	Opening mm.	Average size mm.	Weight retained gms.	Fraction retained %	Fraction retained on %
+ 5	3.962	3.962	3.5	1.4	1.4
— 5 + 8	3.962–2.362	3.16	2.35	0.94	2.34
— 8 + 10	2.362–1.981	2.17	13.60	5.44	7.78
— 10 + 20	1.981–0.833	1.40	32.50	13.00	20.78
— 20 + 30	0.833–0.589	0.71	18.60	7.44	28.22
— 30 + 60	0.589–0.246	0.41	53.15	21.3	49.52
— 60	0.246	0.246	126.00	50.4	99.92

Thus it appeared that the dust could be divided into three major fractions :

(I) Upto 1.4 mm. and above 20%
(II) Between 1.4 and 0.4 mm. 30%
(III) 0.25 mm. and below 50%

There appeared various possibilities regarding the use of these three fractions namely :

(1) 20 per cent of the dust under fraction (I) might be used for paper manufacture and under fraction (II) for Mill Board manufacture.

(2) 50 per cent of the dust comprising of fractions (I) and II) might be used for Mill Board production.

(3) Fractions (I) and (II) might be used for cheap grade of writing and printing papers.

(4) Fraction (III) might be used for making particle board or as filler in thermosetting plastic moldings. The results of investigations are discussed below.

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USE OF 50 PER CENT OF DUST UPTO 0.4 MM. AND ABOVE AVERAGE SIZE FOR MILL BOARD PRODUCTION

The first two portions of bamboo dust having particles upto 0.4 mm. (average) size 1 kg. O.D. weight was taken in the electrically heated rotary digester of 25 litres capacity and digested at atmospheric pressure for varying periods. The softened particles were then refined in the Sprout Waldron double disc refiner and beaten to about 30° S.R. in the Valley Beater. The results are given in Table—I.

TABLE—I

	Experiment Number							
	I	II	III	IV	V	VI	VII	VIII
NaOH on B. D. dust, %	15	15	15	20	20	20	20	10
dust : Liquor	1:3.5	1:3.5	1:3.5	1:3.5	1:3.5	1:3.5	1:3.5	1:3.5
Maximum temperature, °C	100	100	100	100	100	100	100	100
Temperature raising time, min.	30	30	30	30	30	30	30	30
Temperature maintaining time, min.	60	90	120	60	90	120	240	240
Relieving time, min.	3	3	3	3	3	3	3	3
NaOH consumption on dust, %	8.0	8.5	8.97	9.2	10.0	—	13.0	8.5
Yield on B.D. dust, %	65.9	65.0	63.0	62.0	61.0	59.25	56.0	63.0

Lower than 15 percentages of caustic soda on dust gave hard pulp which on refining yielded pulp containing shives. Therefore, it was essential to cook the dust with 15 per cent caustic soda. The excess caustic soda left in black liquor could, however, be recycled after make up to 15 percent NaOH for the next cook. Thus the optimum conditions for digestion appear to be :

Caustic soda on B.D. weight of dust, %	15
Dust : Liquor ratio	1 : 3.5
Temperature of cooking, °C	100
Temperature raising period, minutes	30
Time at 100 °C, minutes	60
Relieving time, minutes	3
Caustic soda consumed, %	8
Yield on B.D. dust, %	65.9

Mill board sheets were made of about 1000 gms/sq. metre weight and of thickness about 1.2 mm. The sheets were then lightly calendered after air drying. A quite stiff board with smooth surface was obtained.

An alternative was to use the first fraction of the dust namely 20% for the production of good quality papers. Even the entire 50 per cent could be used for making slightly inferior grade of papers or in case it was desired to use it for good quality papers, then efficient centricleaning seemed essential to avoid specks in the paper sheets. However, it was thought to be more economical to use it for high grade paper manufacture after centricleaning the same instead of making mill board.

PAPER GRADE PULP FROM BAMBOO DUST

The dust was screened through 20 mesh screen and the fraction retained on 20 mesh screen was taken for pulping. The dust was cooked by Kraft process under the conditions given in Table—II.

TABLE—II
DIGESTION CONDITIONS

	Experiment No. I	Experiment No. II
Chemical as NaOH, %	20	20
Sulphidity, %	22.0	22.0
Dust : Liquor ratio	1 : 3.5	1 : 3.5
Maximum temperature, °C	165	165
Temperature raising time, min.	105	105
Temperature maintaining time, min.	120	120
Relieving time, min.	30	30
Chemical consumption on dust, %	18.1	18.5
Yield of unbleached pulp, %	41.2	41.1
Permanganate number	17.7	—

TABLE–III
BLEACHING

	Experiment No. I	Experiment No. II
1. Chlorination		
Available chlorine added on pulp, %	5.0	5.0
Clorine consumed, %	4.78	4.86
Time, min.	45	45
Temperature, °C	Room temp.	Room temp.
pH	2	2
Consistency, %	2.5	2.5
2. Alkali Extraction		
NaOH added on pulp, %	2.5	2.5
NaOH consumed, %	2.0	2.1
Time, hrs.	2½	2½
Temperature, °C	45	45
Consistency, %	5	5
3. Ist Hypochlorite treatment		
Available chlorine added on pulp, %	2.5	2.5
Chlorine consumed on pulp, %	2.3	2.2
Time, hrs.	3	3
Temperature, °C	35	35
pH	9	9
4. IInd Hypochlorite treatment		
Available chlorine added on pulp, %	1.2	1.2
Chlorine consumed, %	1.2	1.2
Time, hrs.	4	4
Temperature, °C	Room temp.	Room temp.
pH	9	9
Total chlorine required, %	8.3	8.3
Bleached pulp yield, %	36	35.8
Brightness, °G.E.	74	75
Copper number	1.1	1.2

STRENGTH PROPERTIES

The average strength properties were as follows at 45° S.R. freeness :

	Experiment No. I	Experiment No. II
Breaking length, metres	4875	4800
Burst Factor	52	50
Tear Factor	65	67

The strength properties are satisfactory and almost equal to those obtained from the pulp of bamboo chips. But since the dust of this size is only 20% of the total dust, it would be worthwhile to use smaller size dust also to increase the percentage of dust utilized. This pulp could be used for blending with normal pulp after centricleaning the same.

DIGESTION OF BAMBOO DUST

(+60 mesh size)

The dust received from chipper house was screened through 60 mesh and the fraction retained on 60 mesh was taken for digestion. Dust and dirt and other undesirable materials were removed with—60 mesh size. This was necessary to keep the pulp quality satisfactory. As is evident from Table—I, the + 60 mesh size would form about 50%; of the total dust.

The dust was digested by Kraft process under the following conditions :

TABLE—IV
DIGESTION CONDITIONS

	Expriment No.				
	I	II	III	IV	V
Chemicals as NaOH on dust, %	20	18	20	18	18
Sulphidity, %	20.4	20.4	20.4	20.4	22.3
Maximum Temperature, °C	165	165	160	160	155
Temperature raising time, min.	105	105	105	105	105
Temperature maintaining time, min.	120	120	120	120	120
Relieving time, min.	30	30	30	30	30
Chemical consumption on pulp, %	18.3	17.5	17.9	17.0	16.4
Permanganate number	17.5	19	20.7	22	23
Unbleached pulp yield, %	38.1	39.2	41.0	42.8	44.0
Nature of pulp	Shivy	Shivy	Shivy	Very shivy	Very shivy

The pulp was then bleached in four stages as follows :

TABLE—V
BLEACHING

	Experiment No.				
	I	II	III	IV	V
1. *Chlorination*					
Available chlorine added, %	6.0	6.0	7.0	8.0	9.0
Chlorine consumed, %	5.75	5.9	6.7	7.6	9.0
pH	2	2	2	2	2
Temperature, °C	Room temp.	Room temp.	Room temp.	Room temp.	Room temp.
Time, min.	45	45	45	45	45
Consistency, %	2.5	2.5	2.5	2.5	2.5
2. *Alkali Extraction*					
NaOH added on pulp, %	2.5	2.5	2.5	2.5	2.5
NaOH consumed, %	2.0	2.2	2.4	2.4	2.45
Temperature, °C	45	45	45	45	45
Time, hrs.	2.5	2.5	2.5	2.5	2.5
3. *Ist Hypochlorite*					
Chlorine added on pulp, %	3.0	3.0	3.5	4.0	4.5
Chlorine consumed on pulp, %	2.6	2.75	2.88	3.0	4.1
pH	9	9	9	9	9
Time, hrs.	3	3	3	3	3
Temperature, °C	35	35	35	35	35
4. *IInd Hypochlorite*					
Available chlorine adddd on pulp, %	1.5	1.5	2.0	2.0	2.5
Chlorine consumed on pulp, %	1.0	1.5	1.5	1.2	1.0
Temperature, °C	Room temp.	Room temp.	Room temp.	Room temp.	Room temp.
Time, hrs.	4	4	4	4	4
Total chlorine consumption on pulp, %	9.35	10.15	11.08	12.1	14.1
Brightness, °G.E.	71	70	71	70	72
Bleached pulp yield, %	35.3	36.8	38.5	40.1	42

BEATING

The pulps were beaten to 45° S.R. freenessi n laboratory Valley Beater but in the initial experiments nos. I and III, the pulps were beaten to 60° S.R. also to check the strength properties. Sheets were made on standard British sheet formation machine of 60 gms/m² weight. The strength properties were as follows :—

TABLE—VI
STRENGTH PROPERTIES

	45° S.R.					60° S.R.	
	I	II	III	IV	V	I	II
Breaking length, metres	5245	5370	5565	5600	5750	5430	5850
Burst Factor	39.1	40	41	42	42.5	44.4	52.1
Tear Factor	55.9	55.0	54.4	54.0	53.5	49.0	47.7

The paper prepared from the dust had satisfactory strength but contained tiny black specks, dirt and dust and other foreign material. This external undesirable material could be removed from the pulp during centricleaning. The tear factor is slightly lower. Centricleaning could not be done in the laboratory.

FINE DUST

The fine dust of size below 0.25 mm. which is about half of the total dust, might be used for making compressed resin bonded boards to be used as table tops, partitions etc. The dust could be moulded in various form such as handles, wooden carvings, toys, pegs and other irregular shapes which do not require many minute details of the mould.

Freshly prepared urea formaldehyde resin was used as bonding material.

DECORATIVE PROPERTIES

The faces of the blocks of Exp. No. 3rd and 4th were rubbed with sand paper. The faces became quite smooth. A wood polish was applied on the faces in red and light brown colour, the blocks attained satisfactory shining polish. This indicates that the casted pieces can be very well decorated and polished.

PARTICLE BOARD

Boards of sizes 8″×8″×2″ and 12″×12″×3/4″ were prepared using the urea formaldehyde resin.

The following proporation was used :

Dust (—60 mesh size)	100 gms.
Formalin	100 gms.
Urea	30 gms.

Dust : resin solution 1 : 1.6

Exp. No.	Weight of dust gms.	Resin solution cc.	Water added cc.	Compressive strength tons/sq.inch	Water absorption gms. in 24 hrs.
1	125	100	100	1	175
2	125	150	50	3	119
3	125	175	25	4	93
4	125	200	—	4.3	53

PREPARATION OF UREA FORMALDEHYDE RESIN

Formalin (about 30% formaldehyde) was neutralized to pH 4 by N/10 NaOH solution. The formalin was then heated to about 90° C and then solid urea was added slowly with constant stirring after cooling the solution was adjusted to pH of about 8 by adding Ammonium Hydroxide solution.

EXPERIMENT

In an experiment, to ascertain the minimum quantity of resin required for dust binding, the resin was mixed in the dust in different proportions and then after complete setting, the compressive strength was determined in the cement laboratory of M/s. Rohtas Industries Ltd. (Cement Div.). The water absorption was also found out by immersing the blocks in water for 24 hours at room temperature. The dust blocks were made of the standard dimensions of cement blocks for testing the compressive strength. The density of all the blocks was kept same for comparison.

Urea formaldehyde resin was prepared using 600 ml. formalin and 180 gms. urea. The total volume of the cold resin solution became 650 ml. at the end of preparation.

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The boards had sufficient strength and smooth polishable surface. These could be easily sawed and cut like wood. Hence they could be used as table tops and partitions.

CONCLUSIONS

1. Satisfactory paper could be manufactured from dust of average size above 0.4 mm. But since the pulp contained tiny black specks efficient centricleaning was necessary.
2. The fraction of above 0.4 mm. size may be used for the manufacture of Mill Board also.
3. The fraction below 0.25 mm. size may be used in the manufacture of casted articles such as toys, carvings, handles and pegs and other irregular shapes. Thick boards to be used as table tops and partitions could also be manufactured. The proportions may be as follows :

Dust	100 gms.
Formalin	100 cc. (30% formaldehyde)
Urea	30 gms.

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