

Cold Soda Pulping of *Casuarina Equisetifolia*

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ABSTRACT:-- Cold soda pulping characteristics of *Casuarina equisetifolia* are discussed for its use in newsprint furnishes. The cold soda pulps were prepared using 15, 25 and 35 gpl caustic soda solution. The unbleached pulp yield obtained was in the range of 81.4-83.5%. The caustic soda consumption varied from 5.6-7.0%. The unbleached cold soda pulp brightness varied from 38.2-39.2%. Bleached pulps with satisfactory optical and physical strength properties were prepared by single stage calcium hypochlorite bleaching with 6-8% dosage as available chlorine. It was observed that wood chips treated with 25 gpl caustic soda solution after refining and bleaching with 6% calcium hypochlorite gave best results among the conditions investigated. The brightness of the pulp obtained from this treatment improved from 38.6-52.8%. The optical and physical strength properties were determined at 150 ml CSF and at this freeness the initial wet web tensile index, burst index, tensile index and tear index 0.88 Nm/g, 3.7 kPam²/g, 62.5 Nm/g and 3.5 mNm²/g, respectively of the pulp prepared with 25 gpl caustic soda application and bleached with 6% calcium hypochlorite. The specific scattering coefficient and opacity was 32.8 m²/kg and 90.6% respectively. The wet web tensile index and water retention values were close to the values generally obtained for chemical pulps. The higher initial wet web tensile index indicates about satisfactory runnability of pulp on a papermachine. The optical and physical strength properties of the pulp obtained from *Casuarina equisetifolia* showed its potential as a promising source of pulpwood for the manufacture of high yield pulp for newsprint and other cheap grade paper furnishes.

INTRODUCTION

High yield pulping is a very important pulping process and gaining importance day by day in the context of ever increasing shortage of raw material and environmental considerations. One gets very high yield from unit weight of raw material and very less amount of wood constituents go as waste and hence less or no stream pollution; whereas in chemical pulping about 50-55% of wood constituents mainly lignin and degraded carbohydrates go waste in the form of black liquor. The chemical pulps have much stronger physical strength properties as compared to

high yield pulp. This led the technologist to work on the production of high yield pulps by using or modifying the process in such a way that along with the high yield stronger pulps are obtained. In this way use of high yield pulp will increase and use of low yield expensive chemical reinforcement pulps in printing grades papers can be reduced (1). Among the various high yield pulping process, chemi-refiner

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mechanical pulping process is gaining importance and efforts are made to explore the possibilities of producing strong pulps for newsprint grade and other varieties of cheaper grades of paper. In cold soda pulping chips are presoaked in a solution of sodium hydroxide. Sodium hydroxide penetrates deep into chips and some wood components dissolved in it. Fibres in the chips swells, middle lamella is softened hence fibres can be separated in a disc refiner (2). Investigation carried out to find out the pulp and paper making characteristics of *Casuarina equisetifolia*, a promising and potential raw material by cold soda process are presented in this paper.

EXPERIMENTAL

Casuarina equisetifolia wood logs were chipped in the pilot plant four knife Waterous Chipper after removing the bark. The chips were screened on a Waterous vibratory screen. The wood chips passing through a 44 mm square wire mesh and retained on 65 mm square wire mesh were collected and the moisture content of chips determined. The chips were stored in polyethylene plastic bags for further studies (3).

Chemical pretreatment was carried out with 15, 25 and 35 gpl caustic soda solution by soaking the chips at liquor ratio of 1 : 7 for six hours at room

temperature.

After the treatment, the chips were removed. The spent liquor collected was analysed for total solids and residual alkali.

The treated chips were refined in laboratory Sprout Waldron 12 inch disc refiner in two passes keeping 8% and 10% consistency, respectively. After refining the pulps were screened in a laboratory flat screen of 0.25 mm slit width. The yield and brightness was determined and results are recorded in Table-1.

Bleaching experiments were conducted using calcium hypochlorite in single stage. The bleaching conditions are recorded in Table-2. After bleaching

Table-1

Cold soda pulping characteristics of <i>Casuarina equisetifolia</i>			
Sl. Particulars. No.	Experiment No.		
	1	2	3
1. Chemical applied as NaOH, g/lit.	15	25	35
2. Chemical consumed as NaOH, g/lit.	7.6	8.2	10.6
3. Chemical consumed as NaOH, %	5.6	5.8	7.0
4. Total yield, %	83.5	81.6	81.4
5. Screen rejects, %	0.81	0.52	0.41
6. Unbleached pulp brightness, %	39.2	38.6	38.2
7. Total solids in spent liquor, % (W/W)	2.5	3.9	4.8

Table-2

Single stage calcium hypochlorite bleaching of *Casuarina equisetifolia* cold soda pulps

Experiment No.	Hypo applied as available chlorine (%)	Hypo consumed as available chlorine (%)	Initial pH	Final pH	Brightness (%)	P.C. No.	Bleaching losses (%)	Bleached pulp yield on oven dry pulp (%)
1.	6.0	6.0	10.4	9.8	55.9	0.3	4.4	95.6
	8.0	8.0	10.5	9.7	57.8	0.5	6.2	93.8
2.	6.0	6.0	10.7	9.8	52.8	0.1	5.4	94.6
	8.0	8.0	10.9	9.5	57.9	0.3	6.5	93.5
3.	6.0	6.0	10.3	9.6	52.4	1.6	6.0	94.0
	8.0	8.0	10.4	9.4	55.1	2.7	6.8	93.2

Constant conditions

Consistency	8%
Temperature, °C	45 ± 10°C
Time	60 min.
H ₂ SO ₄ wash at pH	5.0 to 4.5

the pulps were given dilute sulphuric acid wash, filtered and finally washed with water.

Pulps were fractionated in the Bauer McKNett fibre classifier using 28, 48, 100 and 150 mesh screens. The results are given in Table-3.

Pulp evaluation was carried out using PFI mill,

handsheets of 100 gsm were made using back water recirculation system. The handsheets were tested for their physical strength properties using standard procedure. Wet web strength was also determined. The results are recorded in Table-4 and 5. The data on physical and optical properties of bleached pulps are given in Table 6 and 7.

Table-3

Bauer McKNett fibre classification of *Casuarina equisetifolia* cold soda bleached pulp

Particulars	Experiment No.	+28 (%)	-28/+48 (%)	-48/+100 (%)	-100/150 (%)	-150 (%)
Cold soda	1	30.60	13.50	19.20	12.20	24.50
Casuarina equisetifolia	2	27.70	11.00	22.00	13.80	31.50
pulp bleached with 6% Hypo.	3	22.23	7.14	24.33	11.89	34.41
Cold soda	1	22.60	12.35	30.15	11.50	23.40
Casuarina equisetifolia	2	18.10	13.50	25.61	15.60	27.19
Pulp bleached with 8% Hypo.	3	20.56	13.45	30.46	12.62	22.91

Table-4

Physical strength properties of *Casuarina equisetifolia* unbleached cold soda pulps

PFI rev.	Freeness CSF (ml)	Apparent density (g/cm ³)	Burst index (kPam ² /g)	Tensile index (Nm/g)	Stretch %	Fold kohler Molin (log)	Tear index (mNm ² /g)	Air resistance Gurley (S/100ml)	IWWT index (Nm/g)	W.R.V. %
Experiment 1										
0	550	0.53	0.91	24.8	2.3	0.80	4.35	26.3	0.51	170
2000	400	0.61	1.25	40.5	2.8	1.32	5.0	185	0.70	177
4000	305	0.65	2.10	43.7	3.1	1.41	5.1	270	0.69	180
8000	185	0.70	2.40	51.0	3.5	1.72	4.65	785	0.80	186
12000	145	0.71	2.38	50.6	3.4	1.70	4.35	790	0.79	188
Experiment 2										
0	490	0.56	1.04	27.8	2.4	1.10	4.67	27.6	0.46	154
2000	360	0.67	2.49	46.5	2.6	1.43	5.15	157	0.72	160
4000	290	0.68	2.59	50.8	2.7	1.56	4.68	503	0.74	171
8000	190	0.70	2.85	52.9	2.8	1.75	4.48	590	0.80	176
12000	140	0.73	3.10	53.9	3.2	2.1	4.31	1421	0.81	190
Experiment 3										
0	540	0.49	0.85	26.1	2.1	0.77	4.31	30	0.39	145
2000	430	0.63	1.75	40.8	2.5	1.19	4.65	120	0.63	150
4000	330	0.66	2.0	45.9	3.1	1.49	4.49	225	0.67	160
8000	220	0.74	2.59	48.9	3.6	1.58	4.19	650	0.70	175
12000	155	0.76	2.68	52.1	3.7	1.65	4.26	1490	0.81	181

Table-5

Physical strength properties of *Casuarina equisetifolia* cold soda unbleached pulps 150 ml. CSF

Sample Code	IWWT index (Nm/g)	Burst index (kPam ² /g)	Tensile index (Nm/g)	Tear index (mNm ² /g)
Experiment 1	0.76	2.35	51.0	4.45
Experiment 2	0.82	3.05	54.0	4.35
Experiment 3	0.78	2.65	52.5	4.15

Table-6

Strength and optical characteristics of *Casuarina equisetifolia* cold soda pulps bleached with 6% Hypochlorite

PFI rev.	Freeness CSF (ml)	Apparent density (g/cm ³)	Burst index (kPam ² /g)	Tensile index (Nm/g)	Stretch %	Fold kohler Molin (log)	Tear index (mNm ² /g)	Air resistance Gurley (S/100 ml)	Brightness (%)	SpScatt Coeff. (m ² /kg)	Opacity (%)	Yellowness (%)
Experiment 1												
0	460	0.57	0.79	28.9	2.6	0.83	4.65	36.3	53.5	36.8	94.1	29.3
2000	310	0.66	2.45	48.1	3.1	1.58	4.43	330	51.5	35.6	92.1	31.1
4000	230	0.69	2.79	51.8	3.3	1.80	4.65	615.0	50.5	33.5	91.3	32.1
8000	150	0.75	3.32	59.8	3.4	2.1	4.35	1270	49.9	32.1	90.2	32.4
Experiment 2												
0	470	0.57	0.76	24.0	2.0	0.91	4.60	31.0	52.3	43.4	94.1	28.6
2000	300	0.67	2.72	50.1	3.1	1.78	4.53	36.5	50.9	36.6	93.2	30.1
4000	240	0.70	2.93	53.9	3.1	1.87	4.31	637	48.1	33.6	91.5	31.5
8000	170	0.73	3.65	60.8	3.1	2.23	3.85	1650	47.3	31.2	91.2	31.4
Experiment 3												
0	530	0.60	0.85	25.1	1.5	0.90	4.51	17.0	53.6	42.1	92.2	30.8
4000	290	0.73	2.65	51.5	3.0	1.90	4.10	486	49.5	33.6	91.2	34.3
8000	190	0.79	3.30	54.5	3.2	1.99	4.20	1243	48.6	31.5	90.9	34.6
10000	125	0.85	3.51	61.5	3.4	2.31	3.82	1670	46.5	28.1	89.7	36.1

Table-7

Strength and optical characteristics of *Casuarina equisetifolia* cold soda pulps bleached with 8% Hypochlorite

PFI rev.	Freeness CSF (ml)	Apparent density (g/cm ³)	Burst index (kPam ² /g)	Tensile index (Nm/g)	Stretch %	Fold kohler Molin (log)	Tear index (mNm ² /g)	Air resistance Gurley (S/100 ml)	Brightness (%)	SpScatt Coeff. (m ² /kg)	Opacity (%)	Yellowness (%)
Experiment 1												
0	450	0.58	0.73	24.1	1.8	0.86	4.38	25	54.3	42.1	92.6	33.1
2000	290	0.65	2.73	48.1	2.8	1.73	4.92	321	52.6	33.8	89.4	35.1
4000	215	0.70	3.11	56.5	3.1	2.01	4.21	750	50.1	31.6	89.2	35.8
8000	150	0.75	3.52	59.3	3.2	2.09	4.15	1430	49.8	30.7	88.2	36.3
Experiment 2												
0	510	0.61	1.0	26.2	2.5	0.94	5.21	30	56.2	41.5	91.6	29.5
4000	450	0.70	3.15	53.9	3.5	1.84	4.43	350	52.5	33.8	89.4	31.9
8000	180	0.75	3.35	55.8	4.0	1.97	4.38	1350	52.1	31.6	87.8	31.7
12000	110	0.81	4.23	62.8	4.1	2.06	4.15	1650	52.2	29.2	87.1	32.3
Experiment 3												
0	520	0.57	0.93	24.3	1.8	0.82	4.31	21.5	54.9	41.3	91.7	31.1
4000	290	0.75	3.00	54.5	3.1	1.90	4.1	730	50.8	31.5	88.1	34.3
8000	145	0.78	3.52	59.3	3.2	2.28	3.56	1650	50.2	28.6	86.1	34.8
12000	90	0.85	3.96	66.5	3.5	2.13	3.15	1800	47.8	24.6	83.1	35.5

RESULTS AND DISCUSSIONS

It could be seen from the data in Table-1 that when the concentration was increased from 15 to 35 gpl, the absorption of caustic soda increased from 5.6% to 7.0%. The pulp yield had come down by 2.0% and varied between 81.6 to 83.5%. There was slight reduction in brightness. The brightness of unbleached pulps were about 39% in case of all the three experiments when the wood chips were treated using 15, 25 and 35 g/lit. sodium hydroxide separately (Table-1). It could be seen from the data given in Table-2 that cold soda pulps obtained using 35 gpl sodium hydroxide gave lower brightness and slightly lower pulp yield after bleaching by single stage calcium hypochlorite using 6 and 8% available chlorine. This indicates that soaking the chips in higher strength of sodium hydroxide i.e. 35 gpl is not useful. In all the three sets of experiments the brightness were in the range of 52.4-55.9% and 55.1-57.9% in case of pulps bleached by 6% and 8% calcium hypochlorite respectively.

Bauer McKNett fibre classification of *Casuarina equisetifolia* bleached pulps are recorded in Table-3. The data showed good fibre fraction distribution and absence of shives. The fibre fraction at-150 mesh showed that sufficient fraction about 22.91-31.50% were present in the pulp to obtain good opacity in paper a desirable property in newsprint furnishes. It could also be seen that no definite trend in fines fraction or fibre fraction were obtained at varying concentration of sodium

hydroxide treatment and after bleaching the pulps separately at 6%, 8% available chlorine in single stage by calcium hypochlorite.

The physical strength properties of unbleached pulps are given in Table-4. All the pulps developed strength with decreasing freeness. The strength properties of the pulps at 150 ml CSF are recorded in Table-5. The data in Table-4 and 5 revealed that pulp of experiment 2 gave comparatively better results than the pulps of other two experiments.

The results of physical and optical properties of bleached pulps by bleaching in single stage with calcium hypochlorite at 6 and 8% available chlorine dosages are given in Table-6 and 7. The physical strength and optical properties of bleached pulps at 150 ml CSF are shown in Table-8. It could be seen from the Table-8 that opacity of the cold soda pulps decreased as the sodium hydroxide concentration was increased from 15-35 gpl. The bleaching with 8% calcium hypochlorite gave higher brightness 49.8-53.3% but other important properties of paper such as initial wet web tensile index and tensile index, opacity were lower than the pulp bleached by 6% calcium hypochlorite. The perusal of data revealed that pulp bleached with 6% calcium hypochlorite of experiment 2 gave moderately good results as compared to all other pulps.

The wet web strength properties and water retention values of all the bleached pulps were determined and data are recorded in Table-9 and

Table-8

Physical strength properties of *Casuarina equisetifolia* cold soda bleached pulps at 150 ml. C.S.F.

Particulars of pulp	Experiment No.	IWWT index (Nm/g)	Burst index (kPam ² /g)	Tensile index (Nm/g)	Tear index (mNm ² /g)	Brightness (%)	Sp.Scatt. Coeff. (m ² /kg)	Opacity (%)
Pulps bleached with 6% Hypo	1	0.86	3.32	59.8	4.35	49.9	32.1	90.2
	2	0.88	3.70	62.5	3.5	47.8	32.8	90.6
	3	0.79	3.45	60.5	4.0	47.2	30.7	90.0
Pulps bleached with 8% Hypo	1	0.79	3.52	59.3	4.15	49.8	30.7	88.2
	2	0.86	3.85	60.9	4.21	52.3	32.4	87.3
	3	0.73	3.54	64.5	3.58	50.5	29.2	86.2

Table-9

Wet web strength properties of *Casuarina equisetifolia* cold soda pulp bleached by 6% calcium hypochlorite

Freeness CSF (ml.)	IWWT index (Nm/g)	ITEA index (mNm/g)	Water retention value, (%)
Experiment 1			
450	0.48	27.0	157
310	0.72	26.0	166
230	0.80	26.0	170
150	0.96	26.0	176
Experiment 2			
470	0.52	31	160
300	0.74	26.0	175
240	0.84	28.0	177
170	0.90	33.0	181
Experiment 3			
530	0.42	21	151
290	0.72	34	157
190	0.77	38	163
125	0.95	40	167

10. It could be seen from the data that wet web tensile index of pulps were higher and are close to the values generally obtained in case of chemical pulps. The higher values especially of pulp bleached with 6% calcium hypochlorite of experiment 2 will increase the runnability of pulp on a paper machine and reduce the amount of chemical pulp in newsprint furnishes.

CONCLUSION

1. The treatment of chips with 25 gpl sodium hydroxide produced better cold soda pulps from *Casuarina equisetifolia*.
2. The brightness of pulp could be increased from 38.6 to 52.8% when bleached with 6% calcium hypochlorite.
3. Pulps with better strength properties particularly tensile, burst, tear indices and wet web

Table-10

Wet web strength properties of *Casuarina equisetifolia* cold soda pulp bleached by 8% calcium hypochlorite

Freeness CSF (ml.)	IWWT index (Nm/g)	ITEA index (mNm/g)	Water retention value, (%)
Experiment 1			
450	0.41	19.0	151
290	0.70	23.0	160
215	0.74	25.0	163
150	0.79	28.0	165
Experiment 2			
510	0.51	28.0	161
450	0.96	42	170
180	0.98	44	175
110	0.99	48	176
Experiment 3			
520	0.40	27.0	152
290	0.65	32.0	171
145	0.78	48.0	182
90	0.78	48.0	114

tensile index could be produced as compared to cold soda pulps from other hardwoods species particularly eucalyptus species. The data showed that *Casuarina equisetifolia* is a promising source of pulp wood and may be utilized for high yield pulping for newsprint and other varieties of cheap grade paper furnishes.

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