Casuarina - A Promising Raw Material for Dissolving Grade Pulp

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ABSTRACT: *In recent years Dissolving Grade Pulp Industry is facing acute shortage of suitable raw materials. Limitations are much more if process is acid sulphite pulping with calcium base. Quality criteria for acid sulphite pulping (with calcium base) is very stringent as all wood materials are not amenable for pulping in this process, because of resin content. Conventional materials like Bluegum, Wattle Wood are fast depleting and can be grown in high altitudes only. The experiments with casuarina as an alternative were examined and results discussed. Wood Pulp produced using casurina is promising.*

INTRODUCTION

Traditionally SIV Industries Limited is dependent on Bluegum (E.globulus) and Wattle (Accacia) for its Rayon Grade Pulp production. As these two plantation species are grown at higher altitudes only, to supplement the needs for production of dissolving grade pulps, E. grandis, E. hybrid (terticornis) and Pinus (Pinus Patula) are also being used. To cater to long term needs of raw materials and to conserve the Ecosystem of the hill-region there is a need for search of alternate raw materials. Casuarina equisetifolia was investigated for suitability and found to be a promising source.

Casuarina equisetifolia (charaku or she-Oak), a native of South Australia, is lofty, quick growing tree with fine filiform branchlets 6 to 8 inch long. There are about twenty species in casuarina but only three or four species are reared in India. The most successful of these for low level plantations has been casuarina equisetifolia. This has average life of fifty years. It is the best of energy plantations for fuel and can be used when 10 to 12 years old. It has been largely planted in sea coasts of South India and Mauritius as wind breakers and also used as fuel. It is mainly for reclaiming sandy seashores. It is environmental friendly and enrich soil with nitrogen.

PULPING PROCESS

SIV Industries Limited since inception use Calcium bisulphite cooking process for its advantages to produce high brightness and low kappa number unbleached pulps from bluegum and wattle. In the cooking liquor, a total SO_2 of 4.8 to 5.2% and total CaO of 1.36 to 1.41% are maintained. As sufficient SO_2 is maintained there is no need for accurate control of chemical charge. However, bath ratio will be approximately 1:2.3. The need to increase bath ratio arise only if wood density is too high or wood is too dried or material has higher lignin content than normal. Cooking temperature, pressure conditions are carefully monitored to maintain viscosity of pulp and its kappa number.

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To make preliminary investigation on suitability of new raw materials for dissolving grade pulping, wood analysis method suggested by W.H. Dore and recommended by Snia Viscosa is followed. This analysis reveal possible interference in cooking process (resinous material), presence of low molecular carbohydrate components (hemi-celluloses and pentosans) and bleached pulp yield.

For all practical purposes, to study the pulpability of new raw materials a liquor circulation type pilot digester of 0.7 M^3 volume with on line steam heater is used.

The analysis of Casuarina wood samples in comparison with SIV preference and normal Bluegum and Wattle are presented in Table-I. The results indicate that Casuarina except for higher ash and CaO content is comparable to Bluegum.

In normal sequence of acidic calcium bisulphite pulping for Bluegum and wattle, a total cooking time of 9-10 hrs is adequate and viscosity monitored at the end of cook. Cooking takes place in two steps (1)

Table-I

Analysis of Wood Material

Sl. No.	Characters	Unit	SIV Preference	Bluegum	Casuarina Sample-1	Casuarina Sample-2	Casuarina Sample-3
1.	Basic density	GM/CC	0.60	0.60	0.772	0.734	0.707
2.	Moisture	%	30.0	--	27.7	19.4	33.6
3.	Benezene Extract	%	0.50	0.25-0.60	0.30	0.21	0.26
4.	Alcohol Extract	%	2.50	1.2-2.0	2.99	2.35	2.22
5.	Cold water Extract	%	1.20	0.2-0.8	0.68	0.63	0.30
6.	5% NaOH Extract	%	5.0	5.0-6.2	6.38	5.21	6.54
7.	Pentosans	%	20.0	18.5-21.0	21.90	21.20	21.26
8.	Lignin	%	30.0	26.5-28.0	30.88	27.95	27.16
9.	C & B Cellulose (By Diff.)	%	42-43	41-44.0	36.36	42.06	41.84
10.	ASH	%	0.30	0.4-0.50	0.51	0.40	0.42
11.	CaO	%	0.11	0.05-0.10	0.29	0.23	0.17

Table-II

Cooking Condition and Cook Liquor Analyses

Sl. No.	Cooking Condition	Unit	Norms	Cook No.I	Cook No.II	Cook No.III	Cook No.IV	Cook No.V	Cook No.VI
I.	Calcium Bisulphite cooking liquor Strength			Vat Cook in plant Digester					
	Total So_2	%	4.8-5.2	--	5.18	4.89	4.89	4.82	4.66
	Total CaO	%	1.35-1.4	--	1.40	1.40	1.40	1.40	1.40
II.	Cooking Cycle Time to reach M. Temperature & Max. Pressure	Hrs.	6.5-7	--	6.75	7.0	5.5	6.0	7.0
	Retention Time Max. Temp. & Max. Pressure	Hrs.	2.5-3.0	--	2.75	3.0	3.0	3.0	2.75
	Maximum Temp.	Deg. C	138	138	138-140	138-140	138-140	138-140	138-140
	Max. Pressure	Kg/CM^2	8.0	8.0	7.5-8.0	7.5-8.0	7.5-8.0	7.5-8.0	7.5-8.0

Note:- In acid sulphite pulping chemical charge, bath ratio, H-factor etc do not arise as excess So_2 and base are maintained. However temperature increased slowly and systematically (from 110 Deg. To 138 Deg.C at 10 Deg.C per hour). This enable better penetration of So_2 as well as base.

Sulphonation (2) delignification. The cooking cycle is split into two stages (1) Time to reach maximum temperature and maximum pressure and (2) cooking time or retention time at maximum temperature and maximum pressure. Generally 6 to 7 hours is taken to reach maximum temperature and maximum pressure and maintained at that condition for 2 to 3 hours. Similarly cooking was carried out for Casuarina also and cooking sequence was slightly varied. The results are shown in Table-II. Cook No. II to No. VI carried in pilot digester.

Properties of unbleached casuarina pulp of different cooks are compared with normal SIV Pulp in Table-III.

Table-III

Unbleached Pulp Characteristics

Sl. No.	Cooking Condition	Unit	Bluegum & Vat Wattle 1 : 1 Pulp	Cook No.I Casuarina	Cook No.II Casuarina	Cook No.III Casuarina	Cook No.IV Casuarina	Cook No.V Casuarina	Cook No.VI Casuarina
1.	Viscosity (Snia method)	CP	40-60	25-43	76	113	85	74	30
2.	Sieber Number	No.	18-22	36-44	49	38	38	41	--
3.	Alpha cellulose	%	88-89.5	90-91	88.3	88.9	88.8	88.7	88.4
4.	Pentosans	%	6.0-7.0	4.5-7.5	9.26	8.09	8.12	8.34	8.95
5.	Resins	%	0.4-0.6	0.4-0.6	0.39	--	0.35	0.30	0.30
6.	ASH	PPM	4000-8000	5000-5500	6170	4340	4020	5020	5630
7.	Cao	PPM	2000-4000	3500-4000	3920	3136	2694	2923	3584

Note:- Snia method of viscosity adopted from snia viscosa Italy, Snia method voscosity multiplied by 1.56 gives approximate value of T-230 viscosity of TAPPI. (CED viscosity)

Sieber number of pulp arrived from nomogram of 'K' number Vs Sieber number adopted from snia method. Sieber number value is approximately 2.8 to 3.2 times than 'K' number (permanganate number) of pulp.

Table-IV

Bleached Conditions-Sequence

Sl. No.	Particulars	Unit	SIV Norms	VAT Cook Casuarina No.I	Pilot Digester Cook Casuarina No.II	Pilot Digester Cook Casuarina No.III	Pilot Digester Cook Casuarina No.IV	Pilot Digester Cook Casuarina No.V	Pilot Digester Cook Casuarina No.VI
1.	Bleaching Sequence	--	C-E-H	C-E-H	C-E-H	C-E-H	C-E-H	C-E-H	C-E-H
2.	Chlorination	%	2.0	4.0	3.3	3.0	2.74	3.11	7.28
3.	Alkali Extraction (At 90-95 Deg.C)	%	4.0	4.0	4.0	5.0	5.0	5.0	6.0
4.	Hypo Bleaching (Hypo as active chlorine)	%	0.9-1.0	1.0	1.5	1.2	1.2	1.7	1.7

REMARKS:

Cook no. VI slightly undercook with higher Sieber number and low viscosity as it is at raising stage. Hence bleach consumption is more.

effluent and the control with the distilled water. The experimental findings are presented in table no. 2 in the form of mean of three replicates.

Table-1.

Physico-Chemical characteristics of paper mill effluent. (Analysed as per methods recommended by: APHA, 1981, Trivedy and Goel, 1986)

Sl. No.	Parameters	Magnitude
1.	Colour	Brown
2.	Odour	Pungent
3.	Temperature	19.10°C - 39.62°C
4.	pH	7.4 - 8.5
5.	Conductivity	1.70 - 3.68 ms cm^{-1}
6.	T.D.S.	1100 - 3110
7.	C.O.D.	2260 - 3520
8.	B.O.D.	240 - 1055
9.	Total Alkalinity as $CaCo_3$	254 - 405
10.	Total Nitrogen	0.80 - 2.84
11.	Ammonia - N.	0.30 - 1.25
12.	Nitrate - N.	0.23 - 0.72
13.	Nitrite - N.	0.14 - 0.38
14.	Sulphate	32.2 - 201
15.	Phosphorous (P)	0.586 - 0.826
16.	Calcium	30.60 - 138.21
17.	Magnesium	10.70 - 70.64
18.	Potassium	8.50 - 30.46
19.	TOXIC METALS (ppm): Fe (3.13), Zn (5.64), Pb (0.35), Cu (1.72), Cd (0.02), Mn (0.31)	

All the values are in Mg/L., except Temp. pH and conductivity.

EXPERIMENTAL FINDINGS

The data presented in Table-2, shows that there is overall reduction in the yield components of the wheat plants due to effluent water treatment. It was found that this reduction continues to increase with the increasing concentration of the effluent treatment in comparison to the healthy control. Plants treated with 25% dilution of the effluent showed very little variation than the control plants, which were treated with distilled water. Maximum reduction was, however, noticed in the plants treated with 100% effluent. In the present investigation number of spikes per ear was reduced from 22.33 to 13.00, number of grains per ear was reduced from 65 to 43; grains weight per ear was lowered from 2.94 gm. to 1.97 gms; ear's weight plant lowered from 52.50 gms to 44.43 gms. in comparison to healthy control. The grain yield per plant was found 29.40 (gm / plant) in control where as it was reduced to 19.70 (gm / plant) in 100% effluent treated plants. Similarly, the biological yield was reduced from 63.23 (gm / plant) to 51.17 (gm / plant) 1000 grains weight was found to be 47.23 gms. in control plants and 26.20 gms. in 100% effluent treated ones. Therefore, the harvest index lowered from 46.47 percent to in control plants to 38.67 percent effluent treated plants.

DISCUSSION

A perusal of literature on yield studies of crop plant with reference to waste water irrigation shows that industrial effluent bring about considerable reduc-

Table-2.

Effect of pulp and paper industry effluent on Yield Components of wheat crop. (var. U.P. 262).

Sl. No.	OBSERVATIONS	Mean of the three replicates				
		Control	25%	50%	75%	100%
1.	No. of spikes / ear	22.33	21	18	15	13
2.	No. of grains / ear	65	61	58	46.66	43
3.	Grains Wt. / ear (in gm.)	2.94	2.81	2.66	2.15	1.97
4.	Ears Wt. / plant (in gm.)	52.50	51.01	50.15	47.50	44.43
5.	Grain yield / plant (gm. / plant)	29.40	28.16	26.63	21.50	19.70
6.	Biological yield (gm. / plant)	63.23	61.05	58.86	55.01	51.17
7.	Test Wt. (1000 grains Wt.)	47.23	45.50	40.02	30.43	26.20
8.	Harvest Index %	46.47	46.05	45.22	39.24	38.67

alternate environment friendly varieties of raw materials like casuarina which can enrich the soil by nitrogen fixation (soil reclamation) would boost the morale of industry.

ACKNOWLEDGEMENT

The authors acknowledge with thanks the help of Mr. M. Balachandar Research Chemist who did the pilot plant cooking studies and Mr. P. Narasimhan, Section Engineer for all the laboratory analytical work. They thank their colleagues in the process department who critically reviewed the experimental procedure, analysis etc and encouraged the team in the trial runs with the pilot digester. Additionally they thank Dr. G.S. Keshavamurthy, Managing Director of SIV Industries Limited who continuously encouraged the R & D work and gave permission to publish the paper.

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