An Experience with Alkaline Sulphite-AQ Pulping of Saccharum Munja for Quality Paper

A.K. Naithani, K.S. Saini and A.K. Chatterjee

ABC Paper, Saila Khurd, Hoshiarpur, Punjab-144 529

Several cooking trials were made with Sarkanda (Saccharum Munja) using Alkaline-Sulphite and AS-AQ pulping with different doze of Anthraquinone. Based on the laboratory findings, plant scale trials have been carried out at ABC Paper. Comparative pulping studies of Sarkanda, by Alkaline Sulphite and Alkaline Sulphite-AQ reveal that there was improvement in cooking and bleaching in all the processes under identical conditions. Results of Anthraquinone at concentration of 0.05% optimum doze in AS-AQ pulping are encouraging with reduced cooking chemicals, cooking time, improved unbleached pulp yield and initial brightness, good strength and substantial reduction in knotter screen rejects. Black liquor has higher organics percentage and calorific value than Alkaline-Sulphite black liquor. Cost savings are achieved as Chlorine consumption reduced and yield increased by 1% and 1.5%, respectively.

INTRODUCTION

In India, forest based raw material is becoming scarce due to unauthorized cutting of trees. 2 million hectare of forest cover is lost every year for increased demand of fuel, fibre, fodder and furniture, besides huge demand of plywood industry. Due to over exploitation of Indian forest cover, 130 million hectare area has been already degraded. Present rate of depletion may result in serious threat to Pulp and Paper Industry and human life too. In this context agro based raw material for making paper seems to be promising alternative specially Northern and Southern belt of India where million of hectares of land is under wheat straw and rice straw cultivation. Forests cover about one-third of the earth's land surface of which about 50 percent is occupied by tropical forest. Of the total geographical area of India 22.74% is forest as against a minimum of 33% forest cover prescribed under National Forest Policy.

Wood which has various applications in domestic and industrial processes viz Pulp and Paper, composite wood, rayon, and other man made fibres, sport goods, furniture, boat building, matches etc. Miscellaneous products like bamboos, resins, gums, some oils, fibres, medicines, katha, lack, shellac etc. are also obtained from forests. Increased urbanization, industrialization and mining have entailed indiscriminate felling of trees and denudation of forests. Due to ruthless cutting of trees and accelerated exploitation of available forest, India is losing 2 million hectare of forest cover every year. According to Tiwan (1982), 22 million hectare of forests have been destroyed during the last three decades. In Punjab another excellent variety of wild grass, called Sarkanda (Sachharum Munja) is available abundantly. This raw material is grown in entire stretch of Punjab-Pakistan border and along the Shivalik foot hills between Himachal and Punjab. It's a seasonal raw material, available from July to November.

PROCESS DETAILS

Fig. 1 shows the flow sheet of Pulp Mill having a capacity of 100 TPD. The plant is designed to process Sarkanda and Straw. The raw material is mainly supplied by the adjoining community after employing labour for cutting during peak season. This green raw material is stored in a stock yard as a buffer stock in several stacks having 200 tonne capacity each. FIFO system is adopted when raw material is used in Pulp Mill to avoid the excess cooking chemical consumption in fresh raw material.

PROXIMATE CHEMICAL ANALYSIS

The lignin percentage is 21%, total cellulose is 79.0%

with 3.1% ash content. Pentosans are high i.e. 26.5% Table 3 . The characteristics of Sarkanda are largely influenced by factors such as soil, water quality, seasonal average rain fall and storage time in stock yard.

MORPHOLOGICAL CHARACTERISTICS

Morphological characteristics are given in (Table-2).

Table-2 Average Length, Average Diameter and Length Diameter, Ratio of Verious Pulp Fibres

	Length (mm)	Diameter (mm)	Ratio
Straws and Grasses			
Rice	0.5	9	60
Espasto	1.1	10	110
Misc. (Wheat, R. Straw, Sabai)	1.5	13	120
Sarkanda	1.39	20	70
Canes and Reeds			
Bagasse (Sugarcane)	1.7	20	80
Miscellaneous	1.2	12	100

Since average fibre length of sarkanda is better than wheat and rice straw, it is considered to be a good raw material for making quality paper. Average fibre length is 1.39mm, average fibre width is 20mm and L/D ratio is 70:1.

MATERIALS AND METHODS

Raw Material

ABC Paper has adopted eco-friendly paper manufacturing process i.e. manufacturing paper without cutting a single tree. ABC paper is utilizing the annually renewable agricultural waste. Material for the purpose of basic raw material for making pulp, such as wild grass called sarkanda (Sachharum Munja). Sarkanda belongs to the family grammineae (Poaceae) , is a very large, erect grass growing in clumps upto a height of 4-5 meters. It grows well on alluvial sandy banks of the river streams and in water logged area and is abundantly available in Northern belt of India alongwith Shivalik foot hills. Culms are biennial, pale, solid, pithy, smooth with an inconspicuous growth ring and root zone. Sarkanda grass is a promising ullulosic raw material, which could easily supplement the growing need of agro residue based Paper Mills for their raw material. The proximate analysis is given in

Table-3 Proximate Chemical Analysis of Saccharum Munja

PARTICULARS		
Cold Water solubility	%	7.6
Hot water solubility	%	10.4
Alcohol, Benzene solubility	%	3.9
1 % NaOH solubility	%	41.8
Lignin %	%	21.0
Pentosan,	%	26.5
Hollo Cellulose	%	79
Ash C'ontents	%	3.1
Cellulose, Cross & Beaven	%	58

(Table-3).

Cooking Chemicals

Sodium Sulphite	-	pH 10-10.5	Purity 75- 78%
Sodium Hydroxide	-	12.5	47.5±0.2%
Anthraquonine	-	6.2	+98%

Cooking Conditions

Cooking Temperature - 165°C

Table-4 Effect of Anthraquinone on Pulping

PARTICULARS		SODA		SODA A.Q		AS		AS-A.Q	
SOD. HYDROXIDE AS Na_2O	%	10.9	10.9	10.9	10.9	6.2	6.2	6.2	6.2
SOD. SULPHITE AS Na_2a	%	-	-	-	-	4.7	4.7	4.7	4.7
ANTHRAQUINONE	%	-	-	0.05	0.05	-	-	0.05	0.05
TIME TO. 105°C	MIN	15	15	15	15	15	15	15	15
TIME AT 105°C	MIN	15	15	15	15	15	15	15	15
TIME 105 To. 165°C	MIN	75	75	75	75	75	75	75	75
TIME AT 165°C	MIN	180	180	135	135	180	180	150	150
MAX. TEMPERATURE	°C	168	168	168	168	168	168	168	168
BATH RATIO		1:2.7	1:2.7	1:2.7	1:2.7	1:2.7	1:2.7	1:2.7	1:2.7
UNBLEACHED YIELD (ON OD R/M SCREENED)	%	49.3	49.1	50.3	49.3	51.2	51.4	52.1	53.0
UNBLEACHED PULP KAPPA No..		26.4	25.7	24.4	23.7	24.0	23.9	21.7	22.1

Table-5 Bauer MC Nett Classifications (Bleached Pulp)

PARTICULARS	SODA	SODA - AQ	AS	AS-A.Q
°SR	38	34	36	32
+50 MESH	29.2	36.6	36.9	44.7
+80 MESH	22.7	9.8	12.7	15.3
+100 MESH	5.2	6.7	5.9	6.1
+200 MESH	6.7	7.9	9.4	9.2
-200 MESH	36.2	39.0	35.1	24.7

Table-6 Bleached Pulp Characteristics

PARTICULARS		SODA		SODA - AQ		AS		AS-A.Q	
PULP CONSISTENCY	%	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5
CHLORINATION									
CHLORINE CHARGED	%	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0
pH INITIAL		1.86	1.90	1.88	1.78	1.96	1.94	1.82	1.92
FINAL		2.40	2.36	2.26	2.34	2.59	2.67	2.41	2.56
TEMPERATURE	°C	Room	Room	Room	Room	Room	Room	Room	Room
RETENTION TIME	MIN	45	45	45	45	45	45	45	45
RESIDUAL CHLORINE GPL		0.2414	0.2556	0.2698	0.2840	0.2059	0.2201	0.2272	0.1988
CHLORINE CONSUMPTION	%	6.42	6.56	6.37	6.29	6.67	6.82	6.56	6.72
pH WASH PULP		3.8	3.71	3.63	3.72	3.69	3.77	3.44	3.56
ALKALI EXTRACTION									
ALKALI CHARGED	%	3.5	3.5	3.5	3.5	3.5	3.5	3.5	3.5
H_2O_2 CHARGED	%	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5
TEMPERATURE	°C	60	60	60	60	60	60	60	60
pH INITIAL		11.89	11.92	12.1	11.79	11.67	11.73	11.86	11.63
FINAL		10.91	10.82	10.78	10.67	10.59	10.70	10.56	10.49
RETENTION	MIN	120	120	120	120	120	120	120	120
KAPPA NO. (WASH PULP)		4.9	4.6	4.1	4.3	4.7	4.4	3.9	4.0
pH (WASH PULP)		8.52	8.56	8.61	8.49	8.47	8.39	8.23	8.17
HYPO STAGE									
HYPO CHARGED	%	5.0	5.0	5.0	5.0	5.0	5.0	4.0	4.0
TEMPERATURE	°C	45	44	40	45	45	46	46	45
RETENTION	MIN	180	180	180	180	180	180	180	180
CHLORINE CONSUMPTION	%	4.84	4.67	4.78	4.72	4.80	4.85	3.96	3.87
TOTAL Cl_2 CONSUMED	%	11.26	11.23	11.15	11.01	11.47	11.67	10.52	10.59
SHRINKAGE.	%	12.8	13.6	11.2	12.2	11.4	12.2	11.4	12.56
TOTAL CHLORINE CHARGED	%	12.00	12.00	12.00	12.00	12.00	13.00	11.00	11.00
BLEACHED YIELD	%	42:99	42.43	43.81	43.64	45.3	45.1	46.14	46.3
FINAL PULP BRIGHTNESS	%	79.0	79.5	81.5	82.0	80.0	80.0	82.5	82.5
VISCOSITY (0.5% C.E.D) cps		7.5	7.4	7.6	7.6	6.9	7.0	7.6	7.6
RESIDUAL CHLORINE	%	0.74	0.77	0.85	0.89	0.53	0.33	0.48	0.41

Steaming	- 1 hour at 100°C
Cooking time	- 3 hours at 165°C
Bath Ratio	- 1:27

Pulping

The cut raw material is de-dusted and mixed with cooking chemicals i.e. Sodium Sulphite, Caustic and Anthraquonine in the lye mixer and fed into the spherical rotary digester having stainless steel cladding from inside. The direct steam is used for cooking. The cooked pulp is blown into a blow tank and subsequently washed in 3 stage brown stock washers, provided with vacuum and counter current washing arrangement. The washed pulp is stored in

Table-7 Strength Properties of Hand Sheets (Bleached Pulp)

PARTICULARS	SODA	SODA - AQ	AS	AS-A.Q
°SR	38	34	36	33
SUBSTANCEg/m²	60.2	60	60.5	61
BULK CM³/g	2.49	2.50	2.51	2.57
BREAKING - LENGTH	2950	3100	3070	3150
BURST FACTOR	15.5	16.1	15.7	16.1
TEAR FACTOR	46.5	47.1	45.0	45.2
ASH CONTENTS %	3.8	3.6	4.3	4.0

Table-8 Characterristics of Weak Black - Liquor

PARTICULARS	SODA	SODA - AQ	AS	AS-A.Q
°TW	8	9	8	9.0
pH	12.4	12.1	11.4	11.3
SPECIFIC GRAVITY	10.32	1.049	1.035	1.033
TOTAL SOLIDS %	7.6	8.4	7.8	8.6
ORGANIC %	64.7	68.7	57.9	59.7
INORGANIC %	35.3	.31.3	42.1	40.3

intermediate storage tower and then refined through Tri Disc Refiners, followed by cowan screen with 1.8mmØ hole, and then cleaned in low density centricleaning system. The cleaned pulp is then thickened in a decker washer and the pulp is ready for bleaching.

Bleaching

The bleaching sequence is C-Ep-H. The bleached pulp is again screened through a Johnson type vibrating screen followed by 3 stage centricleaning. This cleaned pulp is again passed through a finkh screen with a slot width of 0.25mm to remove contraries and resinous material, if any, and finally washed through a vacuum filter. Bleached pulp is stored in a high density tower from where it is supplied to Paper Machine.

RESULTS AND DISCUSSION

Due to excellent fibre characteristics and better strength properties than wheat and rice straw, it opens a new avenue to exploit this raw material (Sachharum Munja) for making better quality pulp using AS-AQ pulping. As AS-AQ pulping results in the production of pulp with lower Kappa No. compared to sulphite and Alkaline Sulphite pulp, it could be possible to reduce the bleach chemical demand substantially. Further, due to the present of lower lignin content in the AS-AQ pulp and the suitable pH, permanence of final product improved.

AS-AQ Pulping of Sarkanda

The properties of unbleached pulp obtained after Alk-Sulfite AQ agro-pulping have shown that cooking time reduced by 30 minutes and unbleached pulp yield increased by 3.8%, 3.0% and 1.7%, when compared with Soda, Soda-AQ and Alkaline Sulphite pulping. Similar trend witnessed in Kappa Number-reuction from 4 to 2 point in AS-AQ pulping (Table-4) . The enhanced delignification is reflected in sharp decrease in both the amount of rejects and the total lignin content in alkaline sulphite - AQ Pulping. However the presence of sulphite decreased the carbohydrate content only slightly

Anthraquinone helps in better panetration of cooking chemicals into the fibre and ensure the soft cooking with low kappa no. thus save the bleaching chemical while maintaining the same brightness level with better strength properties.

Fibre Classification of Bleached Pulp

Fibre classification of sarkanda bleached pulp was carried out in a baner Mcnett classifier and the results are shown in Table-5. Fibres retained on 50 Mesh and passed through 200 Mesh in Soda-AQ and AS was higher than AS-AQ pulp which indicates the higher strength properties of bleached pulp.

Bleaching of Sarkanda Pulp

Sarkanda Pulp was bleached under CEpH sequence as per Mill bleaching conditions for achieving target brightness 82±1%. Table____. Total chlorine consumption reduced by 1.0%. Bleached pulp yield increased from 42.7% to 46.2% when compared with Soda pulping bleached pulp brightness, viscosity, Cl_2 consumption and bleached pulp yield are projected in (Table-6).

Physical Strength Properties of Bleached Pulp

Bleached pulp is beaten to 30°SR freeness in a valley beater and checked for physical strength properties (Table of)

It is clear from the Table that Bulk Breaking length and B.F. improved but tear factor slightly decreased when compared with Soda and Soda-AQ pulp. However, tear factor was comparable with AS pulp.

Black Liquor Characteristics

Black liquor generated from Brown Stock Counter Current washing from unbleached section reveals that pH remained slightly on lower side and specific gravity also decreased marginally when compared with Soda AQ and AS black liquor, Total solids improved almost 1% as compared to Soda black liquor. However, inorganics increased and organic fraction decreased (Table-8).

CONCLUSION

Alkaline Sulphite AQ pulping of Sarkanda seems to be a promising pulping route to achieve brighter pulp, increased yield & improved strength properties with less chlorine, steam and power consumption. Less fines generation in AS-AQ pulping helps in reduced fluff in the final product on paper machine. AS AQ works as a catalyst and induce the better penetration of cooking liquor in the fibre. Uniform pulp quality is achieved with better fibre characteristics. Less chlorine consumption due to faster delignification in bleaching sequence, reduced the effluent load in down stream substantially.

ACKNOWLEDGEMENT

The authors are extremely grateful to Shri Pavan Khaitan, Managing Director of ABC Paper for allowing them to publish this article. They are also thankful to the team members for their active participation in the trial run, evaluation of the system parameters and process optimization.

REFERENCES

- Gary A. Smook, Handbook for Pulp & Paper Technologists Table 1-4, PP 4, fifth edition' 2001
- Standard methods for the examination of water and waste paper, 13thed. CAPHA, AWWA & WPCF, Washington, D.C. 1971.
- A.K. Chatterjee and Narender Sharma, J. V. 7, page 3.
- Whistler, R.L. Methods in Carbohydrate Chemistry , Vol. 3 (Academic Press, New York), 34 (1963)
- John, R. obst, Landucci, L.L. Sanyer N. Tappi 62, No.1 (1979)
- Ghosh, K.L., Venkatesh, V. Chin, N. J. and Gratze, J.S. Tappi 60 (ii); 127 (1977)
- Ferrington, A. Nelson . P.F. and Vanderhock, N. APPITA 31 (2); 119 (1977)
- Halder, R. and Bhattacharya, P.K. Tappi 70 (6) (1980)
- Holton H.H., reprints 63rd Annual meeting of CPPA-TS Feb. 1977, P.A. 07, Pulp Paper Canada 78 (10); T 218 (1977)
- In Fluance of Sulphite on the effectivness of anthra quinone in Soda Pulping, Pingzheng He and Yuan - zong Lai, Tappi Vol. 69, No.12 Pp 89 Dec. (1986)