Jute And Kenaf-Raw Material Supplement For Dissolving Grade Pulping

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ABSTRACT

According to available statistics, approximately wood raw material equivalent to 150 million tonnes of coal is being consumed annually from our Forest base by rural population. Forests remaining today are under severe biotic pressure. It is not because of fuel and fodder needs alone, vast areas of forests are disappearing year after year due to illegal encroachments by resettlers and due to shifting cultivation methods practiced by hill tribes.

When compared to the above reasons for deforestation, Pulp industry consumes about 15-20 % of wood from forest produce by weight basis.

Apart from this, most of the Pulp and Paper Industries in general and Dissolving Grade Pulp Industry in particular augument their cellulosic resources by scientific captive plantation programmes and genetic engineering techniques.

Long back Americans have identified Kenaf as a potential raw material for Pulp and Paper Industry. Jute also being analogous to Kenaf in its chemico-physical properites is a suitable raw materials for pulp industry.

SIV Industries Ltd has conducted some laboratory and mill scale trials for utilising whole jute and whole kenaf to augument its cellulosic resources. Details are discussed in this paper.

INTRODUCTION

To preserve natural forests, National Forest Policy envisages that Pulping Industry has to generate its cellulosic raw material from private sources only.

SIV Industries Ltd located near Coimbatore (Tamil Nadu) produces 175 MT/day Dissolving Grade Pulp for its integrated plant, mainly from Eucalyptus woods. From some time SIV Industries Ltd resorted to importing wood raw material from other countries like Chile. Probably Brazil is having the maximum area of Eucalyptus plantations (Bluegum & Grandis) approximately 30 lakh hectares. In India, it is estimated that about 5.5 lakh hectares are under Eucalyptus plantations, mainly of Eucalyptus hybrid. Dissolving Grade Pulp Industry has to share Eucalyptus Pulp wood with other Pulp and Paper Industries. Hence Eucalyptus wood is insufficient for Dissolving Grade Pulp Industry's needs.

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Compared to plantations of Eucalyptus wood, in India nearly 8.5 lakh hectares of land is under Jute/Kenaf cultivation. India's contribution of jute is nearly 2/5th of World Jute Production.

Considering the availability and basic characteristics, Jute Bast fibre/whole kenaf and whole jute can be a potential raw material supplement for Dissolving Grade Pulp Production provided that raw matetial cost and transportation costs are reasonable.

JUTE / KENAF SCENARIO IN INDIA

Jute bast fibre is referred to as Golden Fibre. As the world's largest producer, India's Jute Bast Fibre production alone reached 1.3 million tonnes in 1993. There were about 70 Jute Mills in 1993. According to one estimate about 2 lakh acres of land is under cultivation of Kenaf in Srikakulam and Visakhapatnam Districts of Andhra Pradesh. Due to invasion of synthetic packing material jute industry is facing tough time to push its products. As such, Jute economy supports 4 million farm families in India. If Pulp Industry accepts Jute as its raw material, mainly farmers will be benefitted.

LABORATORY EXPERIMENTS

Prior to conducting pulping trials, it is customary in-SIV Industries to analyse the cellulosic raw material for its composition. It is because, for dissolving grade pulp industry, wood raw material is a chemical input for producing chemically pure cellulose fibres.

Our wood/cellulosic raw material analysis procedure is based on W.H. Dore method for wood analysis. SIV norms for wood composition and analysis results of jute bast fibres, whole jute and whole Kenaf material are shown in **Table-I**.

Generally whole jute/whole kenaf contains about 35-40% bast portion and 60 to 65 % woody portion. Bast portion will have good quality crystalline cellulose which is evident in wood analysis results.

Table-I

(Wood Analysis/Jute, Kenaf)

S.No.	Particulars	Unit	SIV Norms	Whole Kenaf	Whole Jute	Jute Bast	Decorticated Jute Sticks Without Bast Fibre
1.	MOISTURE	%	30.0	-	-	9-10	9-15
2.	BASIC DENSITY	G/CC	0.5-0.6	VERY LOW	VERY LOW	VERY LOW	VERY LOW
3.	BENEZENE EXTRACT MAX.	%	0.5	0.54	0.39	0.27	0.44
4.	ALCOHOL EXTRACT-MAX.	%	2.5	5.36	2.67	0.61	1.99
5.	COLD WATER EXTRACT MAX.	%	1.2	4.72	2.52	1.41	2.94
6.	5%NaOH EXTRACT-MAX.	%	5.0	12.76	8.35	5.72	9.27
7.	PENTOSAN-MAX.	%	20.0	25.43	22.06	17.24	25.96
8.	LIGNIN	%	30.0	18.08	22.66	19.66	21.15
9.	C&B CELLULOSE BY DIFF.	%	40-43	31-61	39.65	54.69	37.05
10.	ASH	%	0.40	1.50	1.70	0.41	1.90
11.	CaO	%	0.1	0.20	0.03	0.14	0.23

REMARKS: GENERALLY KENAF EXPECTED TO HAVE GOOD CELLULOSE CONTENT. BUT THIS MATERIAL SHOWS LOWER CELLULOSE CONTENT AND MORE HEMIS.

Table-II

(Vat Cook Unbleached Pulp From Jute Bast Fibre)

S.No.	Particulars	Unit	SIV Norms	Vat Cooks 1	2	3
1.	VISCOSITY (SNIA METHOD)	CP	40-60	32	47	54
2.	SIEBER NO.	NO.	18-22	42	24	29
3.	ALPHA CELLULOSE	%	88-89.5	87.5	89.5	89.1
4.	PENTOSANS	%	6.0-7.0	3.23	3.35	3.1
5.	RESIN	%	0.4-0.6	0.60	0.34	0.33
6.	UNBLEACHED PULP YIELD ON OD RAW MATERIAL	%	44-45	71.4	64.66	67.86

* **VAT COOKS:** SAMPLE POT PLACED IN PLANT DIGESTER
- SNIA METHOD VISCOSITY CP IS APPROXIMATELY 1.56 TIMES TAPPI VISCOSITY.
- SIEBER NO. IS APPROXIMATELY 2.8-3.2 TIMES OF TAPPI PERMANGANATE NUMBER.

Whole Jute Constituents

Constituent	Outer bast	Core
Proportion by weight OD	35-40	60-65
Alpha Cellulose	55%	37%
Fibre length	2-4 mm	0.5-0.7 mm

PULPING EXPERIMENTS IN LABORATORY SCALE

Initially pulping experiments were carried by placing vat (sample pot) in plant digestor. Here the pulping conditions are same as plant conditions. Because ours is Acid Sulphite Proceeds, cold blowing is practiced in digestor at the end of cook for SO_2 recovery purpose. Hence, sample pot can be placed and retrieved at convenience. Vat cook unbleached pulp results for jute bast fibre are shown in **Talbe-II.**

This unbleached pulp is bleached in laboratory in C-E-H sequence which is practiced in our Mill. Bleaching conditions are shown in **Table-III.**

Laboratory bleached pulps are analysed for Dissolving Grade Pulp characteristics and compared with SIV regular pulp norms as shown in **Table-IV.**

Because Jute is a bulky raw material, we also carried out prehydrolysis-alkaline pulping trials using 50 litre capacity direct heating (steam heating) rotary digestor. Acid prehydrolysis and steam prehydrolysis results were not satisfactory with jute bast fibre as the fibre tend to crumble and found difficult to control timings precisely. Hence, we opted for water prehydrolysis-soda pulping for jute bast fibre and water/acid prehydrolysis for rest. Pulping conditions are shown in **Table-V.** Unbleached pulp samples were analysed for its characteristics. Unbleached pulp analysis results are shown in **Table-VI.**

Unbleached pulp samples were bleached in laboratory in C-E-H sequence with bleaching additives for viscosity preservation. Bleaching conditions are shown in **Table-VII.**

Table-III

Bleaching Conditions For Jute Bast Fibre/Vat Cook Pulp

S.NO.	PARTICULARS	UNIT	VALUE
1.	CHLORINATION AS AVAILABLE CHLORINE	%	1.5-2.0
2.	ALKALI EXTRACTION WITH NaOH	%	5.0
	SURFACTANT	%	0.15
3.	HYPO STAGE BLEACHING WITH SODIUM HYPO-CHLORITE		
	SODIUM HYPO CHLORITE AS AVAILABLE CHLORINE	%	0.8-1.0

Table-IV

Bleached Pulp Characteristics Of Jute Bast Fibre Pulp

S.No.	Particulars	Unit	SIV Norms	From Vat Cook I	From Vat Cook II	From Vat Cook III
1.	BLEACHING SEQUENCE	-	CEH	CEH	CEH	CEH
2.	BRIGHTNESS (PHOTOVOLT)	%	90-91	90	90	90
3.	VISCOSITY (SNIA METHOD)	CP	28-32	21	39	29
4.	ALPHA CELLULOSE	%	90.5-91.5	88.5	92.9	91.0
5.	BETA CELLULOSE	%	5.0-6.0	10.0	5.4	6.3
6.	GAMMA CELLULOSE	%	3-4	1.5	1.7	2.7
7.	PENTOSANS	%	3.5-4.5	2.42	2.29	2.26
8.	RESIN	%	0.2-0.35	0.23	0.23	0.13
9.	7.14% SODA SOLUBILITY (HOT)	%	12-14	14.3	10.8	14.3
10.	0% SODA SOLUBILITY (OLD)	%	10-11	15.72	13.07	10.37
11.	18% SODA SOLUBILITY	%	5-6	4.72	4.14	3.98
12.	21.5% SODA SOLUBILITY	%	3-4	3.65	3.50	3.12
13.	ASH	PPM	350-600	1380	945	760
14.	CaO	PPM	100-250	129	87	112
15.	COPPER NO.	NO.	1.5	1.48	1.38	1.57
16.	BLEACHED PULP YIELD AD/OD	%	40-41	63.43	60.5	62.46

Bleached pulp samples were analysed for dissolving grade pulp characteristics. Bleached pulp analysis results are shown in **Table-VIII** compared with SIV norms.

Table-VI

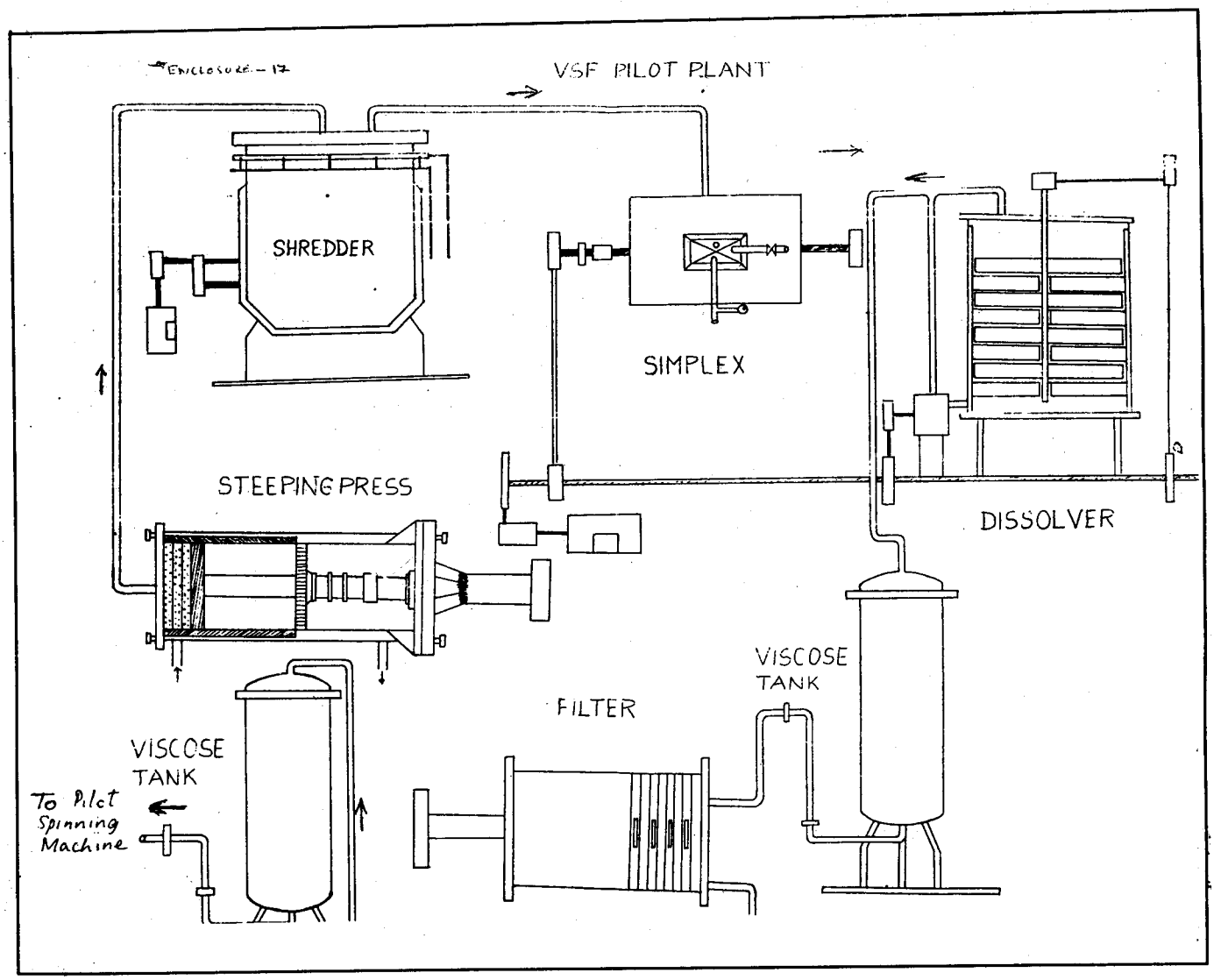
(Prehydrolysis Soda Whole Jute/Jute Bast Fibre Unbleached Pulp)
Analysis Results

SL. NO.	PARTICULARS		SIV NORMS FOR ACID SULPHITE PULPS	WHOLE JUTE PULP SAMPLES				JUTE BAST FIBRE PULP	
				COOK NOS.				COOK NOS.	
1.	PREHYDROLYSIS SODA COOK	NUMBERS	-	1	2	3	4	5	6	7
2.	VISCOSITY METHOD)	(SNIA CP	40-60	55	49	50	81	52	35	50
3.	SIEBER NUMBER	NO.	18-22	36	32	33	34	34	14	17
4.	PENTOSANS	%	6.0-7.0	8.2	8.12	8.39	7.0	5.12	1.27	1.77
5.	RESINS	%	0.35-0.45	0.43	0.43	0.54	0.39	0.38	0.103	0.155
6.	ALPHA CELLULOSE	%	89-90	89.79	90.03	90.93	92.50	92.99	95.80	97.11
7.	ASH	%	-	1.8750	2.226	1.98	1.00	0.92	0.76	0.66
8.	CAO	%	-	0.2968	0.0944	0.0288	0.0288	0.1568	0.0168	0.0205

Table-V

Pre-Hydrolysis-Soda Pulping Conditions

S.	PARTICULARS	UNIT	NO.1 WHOLE JUTE	NO.2 WHOLE JUTE	NO.3 WHOLE JUTE	NO.4 WHOLE JUTE	NO.5 WHOLE JUTE	NO.6 BAST FIBRE	NO.7 BAST FIBRE	REMARKS
1.	PREHYDROLYSIS STAGE									
	TYPE	-	WATER	WATER	ACID	ACID	ACID	WATER	WATER	PREHYDROLYSIS TIME
	TEMPERATURE	DEG.C	155	155	155	155	155	155	155	BATH RATIO AND
	TOTAL TIME	HRS.	2	2	2	2	2	2	1.5	SODA PULPING CON-
	BATH RATIO	-	1:5	1:5	1:5	1:5	1:5	1:5	1:5	DITIONS WERE OPTI-
	pH OF PREHYDRO-LYSED WATER	-	4.4	4.2	4.20	3.8	3.2	3.5	3.4	MISED BY CONDUC-TING MANY TRIALS.
2.	SODA PULPING									
	CHARGE AS NaOH	%	28.38	28.38	28.38	28.38	28.38	28.28	28.38	FOR PREYDROLYSIS
	TTA AS Na_2O	%	22	22	22	22	22	22	22	AND SODA PULPING
	BATH RATIO		1:3:5	1:3:5	1:3:5	1:3:5	1:3:5	1:3:5	1:3.5	TRAILS 50 LTRS.
	COOKING TIME	HRS/ MIN.	2	2	2	2	2	1 HR. 15 MIN.	1.HR 15 MIN.	CAPACITY SS 316, ROTARY TYPE
	TEMPERATURE	DEG.C	155-158	155-158	155-158M	155-158	155-158	155-158	155-158	DIRECT HEATING
	'K'NUMBER OF COOKED PULP	NO.	12.6	11.0	11.5	11.8	11.9	4.3	5.5	DIGESTER (STEAM HEATING) WAS USED.
	DP OF PULP	NO.	1250	1200	1200	1250	1060	1100	-	
	YIELD/OD/OD	%	42.34	-	43.61	41.53	-	46.82	48.45	



PILOT SCALE VISCOSE PREPARATION TRIALS

We do have a small Pilot Plant to produce about 5 to 8 litres of viscose for laboratory evaluation. This pilot equipment comprises Steeping Press, Alkali Cellulose Shredder, Simplex (xanthation) Vessel, Dissolver and Ripening Tanks as shown in Process Flow Sheet.

PILOT SCALE VISCOSE PREPARATION PROCESS

About 500 gms of accurately calculated OD cellulose (after correcting for its moisture content) is taken in the form of small shreaded sheets or crumbs. This is steeped in steeping soda of 18% concentration caustic lye from plant. Steeping is for one hour at 4-5% consistency. This is filtered off pressed thoroughly to 1:2.7 to 1:2.9 press ratio, shredded in shredder and aged in room temperature conditions till the DP level crops to 260 to 270. At this DP level Alkali cellulose is xanmated with 35% CS_2 addition under vacuum conditions at 20 Deg. C temperature for 1 hour 45 minutes. (Reaction can be visually observed as simplex is having see through provision). Xanmate is transferred into dissolver and stochiometric amounts of chilled water, dissolving lye are added for 9% cellulose, 5.5% soda in final viscose. Dissolving is carried with the help of paddle mixer for 1.5 to 2 hours and then along with agitation circulation of viscose also will be carried for another one hour for homogenity.

Table-VII

Bleaching Conditions For Prehydrolysis Soda Pulp

S. No.	Particulars	Unit	Whole Jute Pulp		Jute Bast Fibre Pulp	
			C-EH-H	C-EH-H	CEH	CEH
	OD PULP TAKEN	gms	100	103	100	142
1.	**CHLORINATION STAGE**					
	DOSAGE PERCENTAGE AS AVAILABLE CHLORINE.	%	5.0	5.0	2.5	2.15
	RESIDUAL	%	0.64	0.93	1.05	0.52
	ACTUAL CONSUMPTION PERCENTAGE AS AVAILABLE CHLORINE.	%	4.36	4.07	1.45	1.63
2.	ALKALI EXTRACTION WITH SODA/OR EXTRACTION COMBINED WITH HYPO.					
	NaOH	%	4.0	4.0	5.0	5.0
	SURFACTANT	%	0.15	0.15	0.15	0.15
	SODIUM HYPOCHLORITE AS AVAILABLE CHLORINE	%	2.5	2.5	NIL	NIL
	TEMPERATURE	DEG.C.	95-96	95-96	95-96	95-96
	TIME	Hrs.	1.5	1.5	2.0	2.0
3.	HYPO IST STAGE SODIUM HYPO-CHLORITE DOSAGE AS AVAILABLE CHLORINE.	%	1.0	1.0	1.0	1.5
	BUFFER NaOH	%	0.5	0.5	-	-
	SULPHAMIC ACID	%	0.5	0.5	-	-
	TEMPERATURE	DEG.C.	45-46	45-46	45-46	45-46
	TIME	Hrs.	2.0	2.0	2.0	2.0

The final viscose is analysed for its properties like soda in viscose, cellulose in viscose, total sulphur, ripening index viscosity (Ball Fall) and filterability under standard pressure, temperature filter medium conditions. Conditions for viscose preparation are reported in Table IX. Viscose analysing results are shown in Table-X compared with SIV Viscose Staple Fibre norms.

RESULTS & DISCUSSION

Bulkiness is a problem with whole jute/whole kenaf or jute bast fibre raw materials. Otherwise bast fibre is a rich cellulosic raw material for dissolving grade pulp production.

Acid sulphite process produced high yield of unbleached and bleached pulps compared to prehydrolysis soda process. This can be due to more Hemis loss in prehydrolysis stage. It is also observed that acid sulphite process pulps are easily bleachable to higher brightness compared to prehydrolysis soda process. Easy bleachability of acid sulphite pulps is a proven fact in pulp industry. The advantages noted with prehydrolysis soda pulping are reduced cooking cycle compared to acid sulphite process and relative ease of handling these bulky raw materials.

Lumping tendency and discharge problems are anticipated problems for materials like jute, particularly for cold blowing. Under these circumstances, prehydrolysis-Soda process is ideal as it has not shown much serious problem. Reduced batch operation cooking cycle to hardly 5-6 hours can offset the problems of bulkiness and low digester output. Even though acid sulphite pulps are well bleachable, cooking cycle is lengthy and digester output will be low.

Table-VIII

Pre-Hydrolysis-Soda Process Bleached Pulp Analysis Results

SL. NO.	PARTICULARS	UNIT	SIV NORMS FOR VSF ACID SULPHITE PULP	WHOLE JUTE PULP		JUTE BAST FIBRE	
				CEH-H (4)	CEH-H (5)	CEH (6)	CEH (7)
1.	VISCOSITY (SNIA)	CP	17-22	24	15	14	16
2.	ALPHA CELLULOSE	%	90-91	93.06	91.26	94.31	92.96
3.	BETA CELLULOSE	%	5.5-6.5	6.11	6.28	5.62	6.42
4.	GAMMA CELLULOSE	%	2.5-3.5	0.22	2.46	0.07	0.62
5.	PENTOSANS	%	4.0-5.0	6.82	5.21	1.53	1.54
6.	RESIN	%	0.3-0.4	0.109	0.095	0.11	0.091
7.	10% SODA SOLUBILITY	%	10-12	9.36	10.18	6.52	6.75
8.	18% SODA SOLUBILITY	%	5.0-6.5	6.70	5.16	2.37	2.73
9.	R.YIELD	%	94-95.5	97.65	95.58	96.34	96.46
10.	7.14% SODA SOLUBILITY (HOT)	%	12-14	12.26	6.17	7.96	5.80
11.	21.5% SODA SOLUBILITY	%	3.5-4.5	6.20	4.60	1.27	1.89
12.	ASH MAS	PPM	1500	770	1100	1920	2540
13.	SIO_2 (AI) MAX	PPM	60	290	300	1200	1870
14.	CAO MAX	PPM	1000	56	84	96	112
15.	COPPER NUMBER	NO	1.0-1.5	0.64	0.84	0.85	-
16.	BRIGHTNESS (PHOTOVOLT)	%	87-90	85-86	87-88	88.0	88-89

Table-IX

(Pilot Scale Viscose Preparation Conditions)

SL. NO.	PARTICULARS	UNIT	JUTE BAST FIBRE PULP (6)	JUTE BAST FIBRE PULP (7)
1.	AIR DRY PULP TAKEN	GMS	340	480
2.	CAUSTIC LYE FOR STEEPLING	LTRS	8.0	8.0
3.	CAUSTIC LYE STRENGTH	%	18.2	18.2
4.	STEEPLING TIME	HRS	ONE	ONE
5.	PRESS RATIO	RATIO	1:2:82	1:2:73
6.	ALKALI CELLULOSE WEIGHT	GMS	959	1308
7.	SODA IN ALKALI CELLULOSE	%	15.56	14.75
8.	CELLULOSE IN ALKALI CELLULOSE	%	29.83	33.71
9.	SODA/ CELLULOSE	RATIO	0.52	0.44
10.	INITIAL DP OF AC	NO.	590	--
11.	AGING TIME	HRS	22	30
12.	AGING TEMPERATURE	OE	30	30
13.	FINAL DP OF AC	NO	280-290	250-260
14.	CS_2 ADDITION ON OD CELLULOSE BASIS	%	35.0	35.0
15.	XANTHATION TIME	HRS	1.5	1.5
16.	XANTHATION TEMPERATURE	OC	22	22
17.	DISSOLVING TIME	HRS	3.0	3.0
18.	DISSOLVING TEMPERATURE	0°C	16-22	16-22

Table-X

(Viscose Characteristics-Lab.Scale)

SL. NO.	PARTICULARS	UNIT	NORMS IN VSF PLANT	VISCOSE PILOT PLANT SAMPLE WITH HIGH VISCOSITY	VISCOSE PILOT PLANT SAMPLE WITH LOW VISCOSITY
1.	CELLULOSE IN VISCOSE	%	9.0	9.14	7.66
2.	SODA IN VISCOSE	%	5.5	5.03	5.96
3.	TOTAL SULPHUR IN VISCOSE	%	2.4	2.19	2.06
4.	VISCOSITY BALL FALL	SECONDS	40-60	107	16
5	RIPENING INDEX	-	8-9	5.0	12
6.	FILTERABILITY	KW	LOWER THE BETTER	28930	16860
7.	FILTERABILITY/ VISCOSITY RATIO	KW/N	LOWER THE BETTER	280	1056

REMARKS:- Either at higher Viscosity or at lower Viscosity Viscose exhibited satisfactory filterability. These results are informative and not conclusive for plant scale. Filterability values are slightly high.

VISCOSE QUALITY

In either case acid sulphite pulp or prehydrolysis soda pulp viscose characteristics are encouraging and viscose is filterable. Jute bast fibre is having fairly good quality cellulose. Woody portion of jute sticks induce more pith cells, short fibre and more hemicellulose which can lead to filteration problems. With whole jute/whole kenaf results are satisfactory. However, for better pulp characteristics/ viscose quality, bast fibre portion can be increased by purchasing it separately (to increase the bast portion ratio to woody portion).

MILL SCALE TRIALS

SIV Industries Ltd for its viscose staple fibre production uses 85% Eucalyptus hybrid (E.tereticornis) and 15% Pinus Wood. This is because Pine wood has to be consumed from allotment. Eucalyptus hybrid wood pulp contains short fibre (0.7 mm) and blend of Pine gives better dewatering and better press run for alkali cellulose making. However, the negative point with Pinus is, it is resinous wood giving sticky and filtration problems of viscose. As jute also contains long fibre in its bast portion, we felt that Eucalyptus hybrid : whole jute or whole kenaf combination can produce satisfactory results. In mill scale, we took 95%:5% trial using Eycalyptus hybrid and whole jute/kenaf material for a brief period. We would like to say that as far as Pulp and Viscose qualities are concerned, we have not observed any major problem during that short period of run. However, we have to take more trials in this aspect.

CONCLUSION

The major obstacles of continuously using whole jute and whole kenaf material for pulp industry are its handling and transportation problems. Jute and kenaf are mostly grown in eastern part of India and its long distance transportation costs heavily.

Secondly conventional material handling and raw material preparation equipments are designed

and developed for wood based raw materials only. To make the industry to come forward to use these raw materials, handling and processing equipments have to be designed and developed. Pandia type continuous digester may work for pulping operation. Government has to come forward by giving suitable concessions for encouraging the usage of these materials.

Higher cellulose content in raw material, short cycle of annual crop and per hectare yield of cellulose raw material from whole jute/kenaf compared to woody materials encourage its usage in pulp industry. This helps to augument cellulosic requirements of pulp industry and helps in preserving natural forests.

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