Jute For Speciality Pulp

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ABSTRACT

One of the promising non-wood raw material in India for making high value International quality pulp is jute which can compete & replace the imported softwood pulp. It is available in significant quantities which is capable of development for large scale use by the paper industry. Jute fibre has high alpha cellulose and low lignin content and pulp has good strength but at the same time has constraints like high dirt count, low brightness & high stiffness. Efforts were made to find suitable pulping & bleaching processes to overcome constraints and make the fibre more soft and pliable so as to compare with international quality speciality pulp. The concept of elemental chlorine free and total chlorine free bleaching was followed to produce high brightness pulp.

INTRODUCTION

Speciality papers demand high quality pulps which should have high strength, cleanliness and brightness. Normally, these standards are met by softwood pulps. The pulps made from many non-woods do not meet some of the standards. Indigenous softwood is not available to Indian pulp industry. Hence, the Indian paper industry is dependent on imported softwood pulps. One of the promising non-wood raw material for making high value pulp is jute. Jute is available in any significant quantity on sustained basis which is capable of development for large scale use by the paper industry. Jute fibre consists of individual fibres which are held in bundles. The strands are 1.5 to 2 m long with average fibre length of 2.7 mm and 20 microns diameter. It has a high alpha cellulose and low lignin content. Jute pulp has good strength but few problems as listed below are encountered in extending its use for producing more varieties of speciality papers.

- Removal of internal and external contraries like bark, dirt, plastics, sand and other trash materials.
- Low brightness of pulp if high physical properties are required partly due to entrapped dirt.
- Stiffness of the fibre due to pulping process and fibre characteristics. The fibre needs to be softened.

Under the National Jute Programme, a sub-project on "Jute for International quality speciality pulp" was executed by UNDP, New Delhi, Ministry of Textiles, Govt. of India through CPPRI and ITC-TTD, CPPRI being implementing agency on behalf of Ministry of Textiles. The development objective of the project was to produce high brightness and clean pulp from jute equivalent to International standards. Under the project, successful R&D work was carried out to overcome the problems in utilisation of jute which has helped to produce clean and high brightness pulp using the eco-friendly bleaching process. Investigations were made of various pulping methods with a view to obtain right quality of bleached pulp and to make the fibre more soft and pliable. From an environmental view point the latest trends in bleaching technology were evaluated. The concept of Elemental Chlorine Free and total chlorine free bleaching was followed to produce a high brightness pulp.

This paper highlights some of the findings of the activities conducted under this project. These include examination of fibre characteristics, optimisation of pulping process (laboratory, pilot plant and mill scale) and bleaching of pulp using three

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Table-1			
Fibre Characteristics			
Fibre Property	Jute (bast)	Softwood	Bamboo
Fibre length (mm)	2.8	3.5	2.5
Fibre diameter (um)	18.0	35.45	16
Wall thickness (um)	5.2	3.8	6.6
Flexibility ratio	145	65	155
Runkel ratio	0.6	0.14	0.8
Coarseness (mg/m)	0.19	0.32	0.28
Fines (<200 um) (%)	0.50	6.0	7.5

different bleaching technologies (Chlorine, Elemental chlorine free and total chlorine free).

FIBRE CHARACTERISTICS

The average length of the jute fibre is similar to bamboo, but shorter than softwood. Average diameter of the jute fibre is lower than softwood fibre. The jute fibre is thick walled with narrow lumen. Narrow fibre width accompanied by thick cell wall make the jute fibre stiff compared to softwoods fibre (Table-1). High runkel ratio of the jute fibre render it more suitable for paper requiring high opacity. Coarseness of the fibre measured as weight per unit of fibre length indicates that jute fibres are comparatively less coarse compared to bamboo and softwood fibres. The non-fibrous cells having a shorter length (primary fines, having length < 200 um) are negligible compared to softwood or bamboos pulps.

Fibre Length Distribution

Figure-1 shows the comparison of fibre length distribution of jute with softwood and bamboo. The individual fibre of jute range from <1m to > 5mm in length with an average of 2.8mm. Jute has a sizable proportion of fibre with length range between 2-3 mm (about 45% of total fibres).

PULPING STUDIES

We have a number of pulping methods available for processing of jute fibres. In order to examine and assess the suitability of a pulping process for jute, we must be familiar with the general features of the

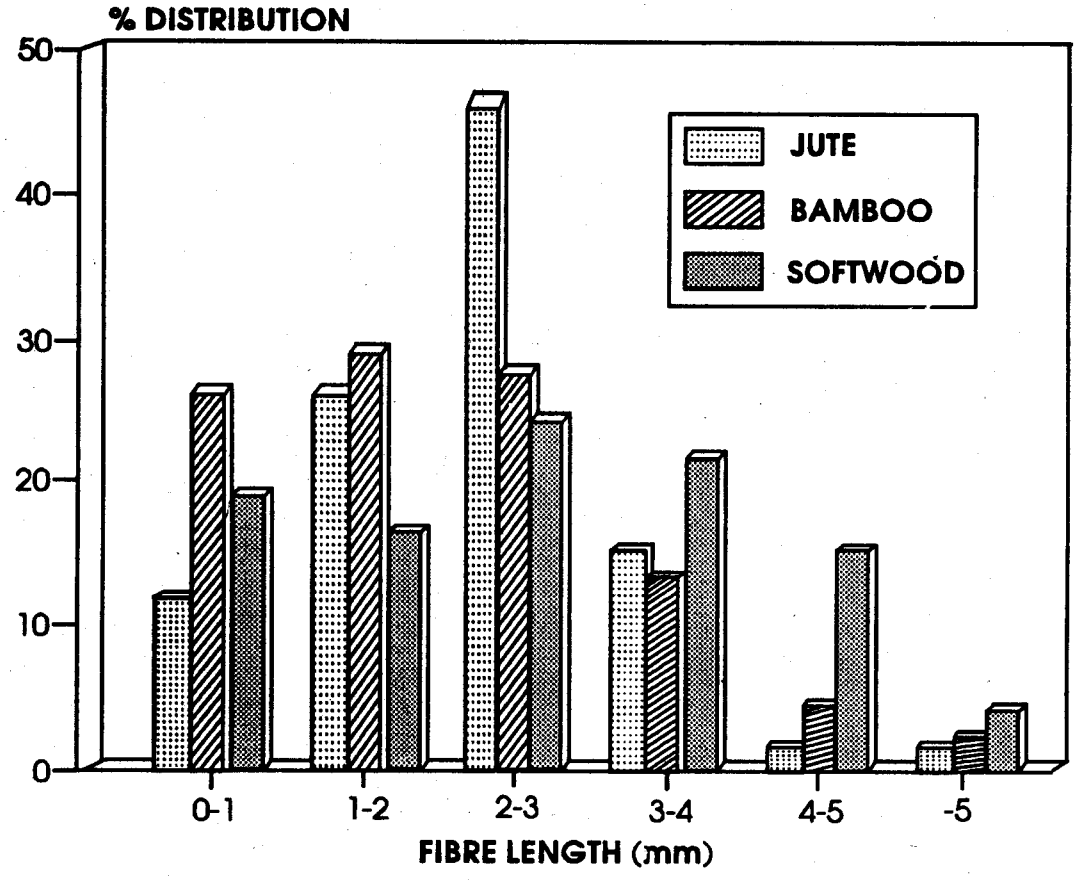


Figure-1. Comparison of Fibre Length Distrubution

Table-2						
Pulp Properties						
Tests	**Pulping Process**					
	Kraft-AQ		**Kraft**		**Soda-AQ**	
	Unbl.	**CEH**	**Unbl.**	**CEH**	**Unbl.**	**CEH**
Viscosity CP	60	24	60	24.5	52	20
Brightness % Elrepho	35.3	78	31.2	78	31.2	79
Breaking length (30 SR) m	7269		6795		6070	
Fibre length mm	1.68	1.71	1.69	1.60	1.76	1.54
Coarseness mg/100 m	10.0	12.9	10.4	10.2	10.1	10.8
Fibre strength Index Nm/g	25.6	12.5	25.0	11.1	25.5	19.1
Slenderness factor 100 x WAFL/Coarseness	16.8	13.3	16.2	15.7	17.4	14.3
Kappa No.	12.0		12.7		11.0	

process with regard to pulp properties and technological considerations. In terms of overall suitability different pulping processes were examined with respect to targetted properties, such as coarseness, slenderness factor, yield, kappa no. and viscosity. Of the known pulping processes, Kraft, Kraft-AQ, Soda, Soda-AQ, Alkaline Sulphite, Alkaline Sulphite-AQ were tried.

Laboratory Pulping

Summary of the results of pulp properties obtained using the above pulping processes in the laboratory are indicated in **Table-2.** The results are shown for only Kraft, Kraft-AQ, and Soda, Soda-AQ pulping tests. The results of alkaline sulphite pulping process had earlier indicated that even with an NaOH/SO_2 ratio of 1:3-1:4, a relative high chemical charge, a high temperature of 165 ^{0}C and long cooking time of 4 hours could not achieve the desired kappa no. of 13 $\pm$ 2. The kappa number using a high Na_2SO_3 charge was usually very high and with addition of 0.05% AQ the lowest kappa no. that could be achieved was approx. 19. The different pulping processes were graded according to kappa no., chemical consumption, chemical recovery yield, viscosity, dirt count, breaking length, slenderness factor, and bleaching chemical consumption. Out of the pulping process tried, it was observed that in soda process required AA charge is 14% (as Na_2O) to get a kappa no. of 13, whereas in kraft process AA charge is about 12% (as Na_2O) to get a kappa no. of about 13. In case of AQ addition the pulp yield was approximately 1% higher than without AQ and also less bleach chemical consumption.

Pulping Trials

Based on laboratory results, experimental trials were conducted at the pilot plant scale using 11 m^3 digestor of tumbling type. Cooking was carried out by direct steaming. After completion of cooking cycle the pulp was blown into a blow tank. During the pilot plant trials, experiments were conducted in which different lengths of jute strands were used ranging from 4 " "to15" " Purpose of using small lengths of jute strands was because it was feared that it may not be possible to blow the pulp using longer strands. However, we observed that even upto 15" length of the jute strands pulp could be blown without any difficulty. One of the important aspect studied during blowing of jute fibre was the optimisation of the pressure during blow, so as to cause minimum damage to the fibre. Higher pressure blow (about 7 kg/cm^2) was observed to cause considerable damage to the pulp fibres, but jute fibres could be blown successfully without any damage at pressures of about 3 to 4 kg/cm^2. Simultaneously, viscosity of the pulp was also severely affected by the pressure. It can be inferred that high pressure blow is not desirable for jute.

Bleachability Tests

Bleachability tests on the pulp produced from different pulping processes was also carried out using the CEH sequence to select the final pulping process. The purpose was to observe which type of pulp had a better bleach response. The results of bleachability test showing the chlorine consumption, the brightness

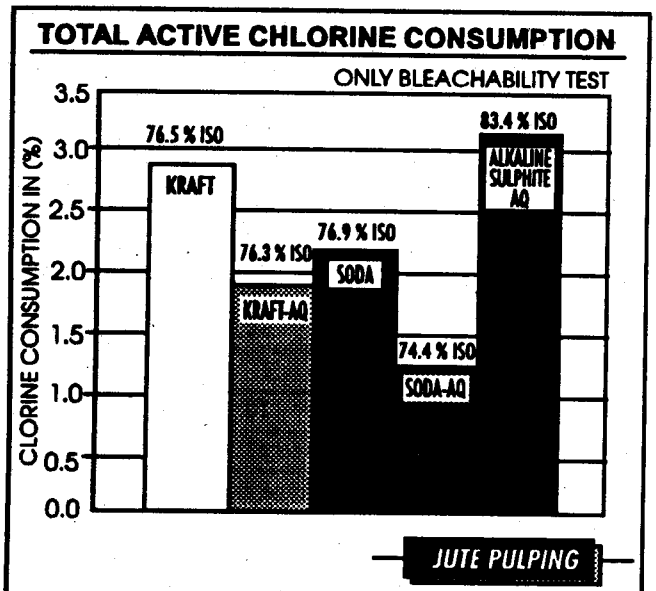


Figure-2. Total Active Chlorine Consumption

obtained are shown in **Figure-2.** Amongst the different pulp types, maximum brightness obtained was for Alkaline Sulphite-AQ pulp (83.4%) and lowest for the soda-AQ. But chlorine consumption was quite high for alkaline sulphite AQ pulp (being 3.2%). Kraft, AQ pulp had the best bleach response in the sense it gave good brightness at low bleach chemical consumption (1.9%).

BLEACHING

The purpose of bleaching is to increase the brightness of pulp, and also to remove any remaining shives and dirt particles. Bleaching should be done by maintaining the physical strength properties and good yield and as economically as possible. Because of cost considerations the Indian paper industry continues to use chlorine and hypochlorite as chemicals for pulp bleaching. From the view point of bleaching technology being practiced in our country, it is difficult to perceive its change over to any other form of bleaching. However, there is another important consideration, i.e. the Government regulatory pressures, to control the release of toxic chloro compounds into waste streams. Alternate bleaching technologies are being adopted in increasing number by the paper industry worldwide to reduce the formation of toxic compounds during bleaching. The mills must adjust to current highly regulated environmental atmosphere. They must be able to adopt technology for reducing effluent and also know regulatory requirements and remain familiar with them as regulation change.

Table-3

Comparison of Brightness of Bleaching Pulp

S.No.	Bleaching Sequence	Brightness, %
1.	CEH	84.8
2.	C Ep h	87.2
	OCEOH	87.0
3.	DED	87.0
	ODEOD	84.4
4.	OQEOP P	84.7
	OQZP	89.3

With this viewpoint, the bleachability of jute pulp was studied using the chlorine, elemental chlorine free and total chlorine free bleaching process.

The sequences studied were-

Chlorine-

C-E-H

C-Ep-EH

O-C-EO-H

ECF-

D-E-d

O-D-EO-D

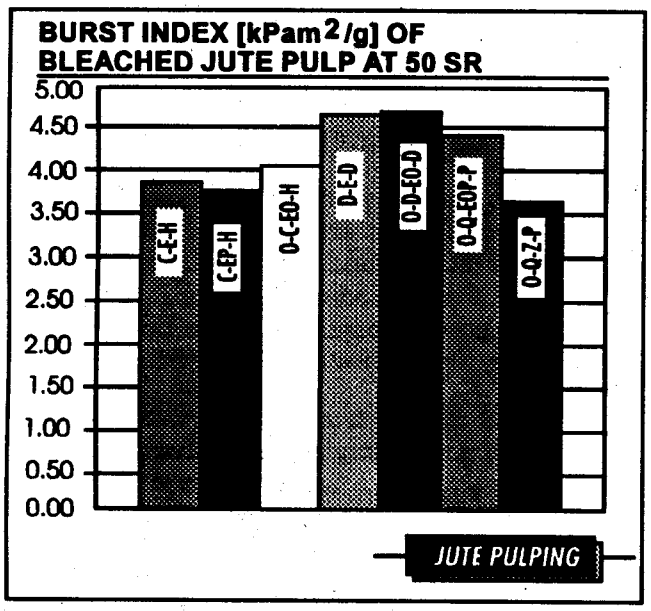
TCF-

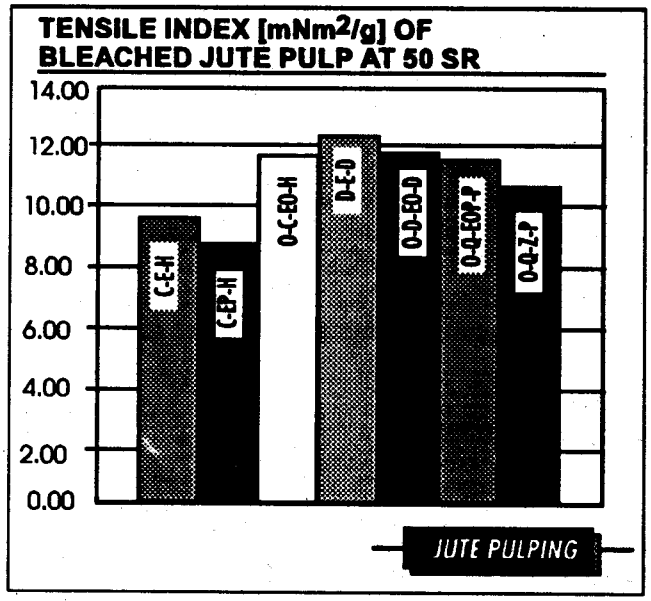
O-A-EOP-P/O-QEOP-P

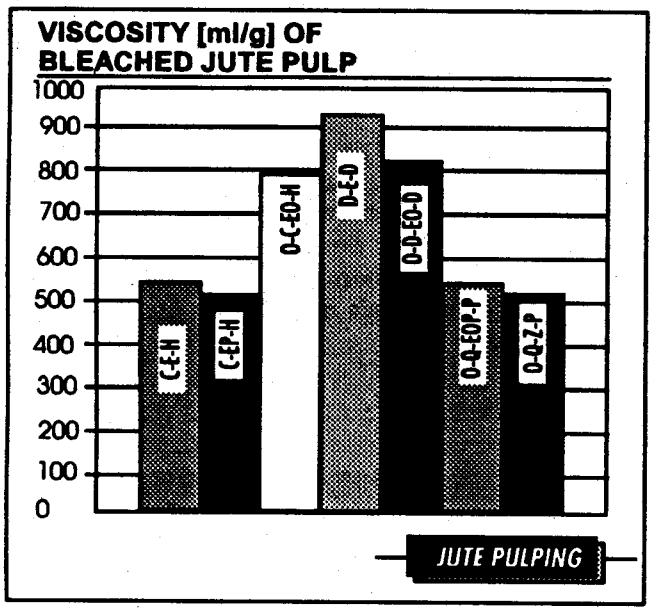
O-A-Z-P/O-Q-Z-P

During bleaching tests the target properties were high brightness (87%), low dirt count (<10 mm^2/M^2), good viscosity (>550 cm^3/gm) and breaking length (> .6.7 km).

Generally, the bleaching results were in acceptable range. With the simplest bleaching sequence using chlorine and hypochlorite a brightness of 84.8% was reached. When peroxide was added in the extraction stage the final brightness reached 87.2%, with a reduced total chlorine consumption. Addition of an oxygen delignification stage prior to the chlorination stage further improved the chlorine consumption.







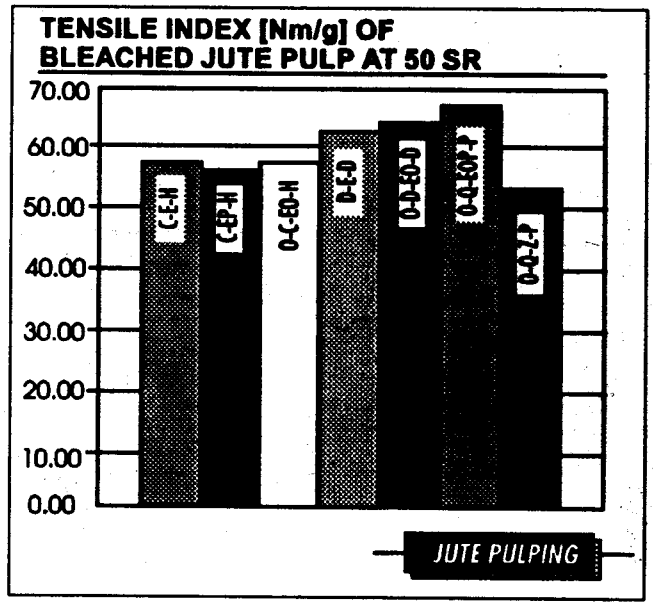


Figure-3. Properties of Pulp from different Bleaching Processes.

Figure-4. Properties of Pulp from different Bleaching Processes.

Introducing chlorine dioxide instead of chlorine and hypo results in a brightness of 87% and addition of an oxygen delignification prior to the first chlorine dioxide stage further improves chlorine consumption.

In the case of total chlorine free bleaching with oxygen, and peroxide the final brightness was low being 84.7%. Introducing ozone in a total chlorine free bleaching sequence, however, increased the final brightness to 89.3%.

Results of pulp brightness obtained on pulps from three bleaching processes are given in **Table-3.**

Results of strength properties using the different pulp bleaching technologies are illustrated in **Figure-3 & 4.** Observations made indicate that during bleaching of pulp using the conventional sequence of CEH, there is considerable loss of viscosity. Likewise tear strength was also adversely affected. Addition of oxygen stage prior to chlorination helped to preserve viscosity and tear strength.

Bleaching of pulp using the Elemental Chlorine Free bleaching system wherein chlorine dioxide was used in place of chlorine produced pulp having the maximum strength. Burst, Tear and Tensile strength

were highest amongst the three bleaching systems. Similarly, the pulp viscosity was not much affected and comparable to that of unbleached pulp.

Likewise bleaching of pulp using the total chlorine free bleaching process gave intermediate properties for the pulp strength. However, in this type of bleaching the viscosity was affected significantly and was very low (comparable to pulp viscosity of CEH bleached pulps). Tear, Tensile and Burst strength were only slightly lower for Elemental chlorine free bleaching.

CONCLUSION

- Jute Bast fibre is the only promising non-wood raw material available in our country for making high value pulp.
- It has average fibre length of 2.8 mm. Fibres are thick walled, stiff and have low coarseness. The primary fines (< 200 um) are considerably low.
- Suitability of different pulping processes based on certain targeted properties like viscosity, yield, kappa no., dirt count, slenderness factor, bleach response, indicated that kraft-AQ is the best process for pulping jute.
- Long strands of jute (more than 15" size) can be blown without any difficulty.
- Pressure during blow is critical and can damage strong fibre structure.
- Pulp bleaching of jute was examined using three different processes, i.e. conventional, elemental chlorine free and total chlorine free, Results indicated that high brightness and good strength pulp can be best produced using the elemental chlorine free bleaching.
- Total chlorine free bleaching with ozone can give a pulp brightness of about 90%.

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