The influence of pulping conditions on the brightness development in ECF bleaching of whole jute

Ravi Kotte and U.K.Ghosh

Jute, is grown in many parts of the world particularly in eastern and central India, Bangladesh and south Asian countries. Due to its long fibre length, paper of considerably high tear and tensile strength, could be made out of it. In this study whole jute, also known as Corchorus Capsularies, was subjected to soda-anthraquinone pulping process with three different levels of soda charge (10,16 and 20%) at three different temperatures (160,165 and 170°C). The resulting pulps were subjected to oxygen delignification. The kappa number reduction after oxygen delignification was of the order of 47 to 51%. The oxygen delignified pulps were bleached through DEDP sequence. Effects of cooking temperature, soda dose, RAA, on the bleached pulp brightness has been studied. The extent to which the kappa number and viscosity of the pulp influence bleaching was also investgated.

Keywords : Whole jute, soda – anthraquinone pulping, ECF bleaching

INTRODUCTION

In India jute, as papermaking making raw material, has not gained enough attention. However, jute bast fibre, which is approximately 25 percent of whole jute has been used for packaging materials for various agricultural, food, industrial commodities and to some extent for carpet backing, hessian, decorative fabrics etc. In pulp and paper industry it can be blended with wood pulp or bamboo pulp for the production of cigarette paper, tag paper, wrapping and bag paper etc. [1,2] leaving behind the jute sticks as the waste. However, the existence of jute fibre in its conventional use is challenged by the synthetic fibres and its export has gradually decreased. Therefore, it is necessary to find some new uses of jute fibre. Research [3,4,5] on whole jute suggests that whole jute having high percentage of cellulose and long fibre is quite suitable as non-wood fibrous raw material for manufacture of different grades of paper and board. Whole jute fibers are longer and stronger than many other conventional nonwood raw materials for paper making. . Whole jute plant contains higher holocellulose and lower lignin compared to bagasse and bamboo [6]. Like wood the whole jute contains less silica [6] which is a positive indication for efficient working of chemical recovery unit. In alkaline pulping process the addition of sulphide ion accelerates the rate of delignification with less damage to cellulose and hemi cellulose, whereas, more severe conditions are required in soda cooking in order to obtain a pulp of desired kappa number, resulting in lower yield than obtained in the kraft process. But Kraft process has a major disadvantage in terms of environmental problem. Addition of anthraquinone in soda process gives better yield than soda process with the added advantage of slight decrease in kappa number. So soda - AQ is better than kraft process, both in terms of process and environment. An understanding of the link between pulping and bleaching is essential when optimizing the pulping process. Bleachability of the pulp is dependent on the raw material and can be influenced by the conditions in the cooking process. Therefore, in the present investigation whole jute plant was subjected to soda –AQ pulping process with different levels of soda charge at different temperatures. The resulting pulps, after oxygen delignification, were bleached through DEDP sequence. Effects of cooking temperature, soda dose, RAA on the bleached pulp brightness has been studied.

Indian Institute of Technology, Roorkee,Department of Paper Technology, Saharanpur Campus Saharanpur-247001,(U.P).

MATERIAL & METHODS

Whole jute was collected from CPPRI, Saharanpur. It was washed and dried under sun and left in polythene bags at room temperature and atmospheric pressure in the laboratory for attaining uniform moisture. Proximate analysis was carried out as per TAPPI standard procedure (Table 1).

Whole jute was pulped using soda – anthraquinone process in a rotatory digester consisting of three bombs of 2.5l capacity each. All the pulping conditions have been recorded in Table 2. Resulting pulps were washed with

Table 1

Proximate analysis of Whole Jute (on O.D. basis)

Particulars	Amount
Cold water solubility, %	3.9
Ash content %	3.54
Lignin, %	22.3
Hot water solubility, %	4.1
1/10N NaOH solubility, %	24.6
Holocellulose, %	76.5
Pentosan, %	17.3

cold water. After thorough washing, those were screened on laboratory screen using mesh with 0.25mm slot width. Pulp yield, kappa number and other properties of the unbleached pulps were determined (Table 3) by TAPPI standard procedure.

Pulps cooked with 12% ,16% and 20% NaOH were subjected to oxygen delignification for further ECF bleaching. The conditions for oxygen delignification has been given in Table 4.

The elemental chlorine free DEDP bleaching sequence was carried out on all the oxygen delignified pulps cooked at nine different conditions. All the bleaching experiments were performed in the laboratory under the conditions given in Table 5, using batch vessels immersed in constant temperature bath. Sodium chlorite solution was used in the D stages to generate chlorine dioxide and the pH was maintained between 4-5. 70 percent of the chlorine demand was fed to the first D stage and the rest 30 percent was charged in the second D stage. Chlorinated lignin derivatives were extracted out by addition of alkali. NaOH added was 0.6 times Cl_2 demand in D stage. After the end of retention time the pulp was washed. To increase pulp brightness without increasing the generation of chlorinated compounds 0.3 percent H_2O_2 was used in the P stage. After determining yield and viscosity, handsheets were prepared in British sheet former under standard pressing and drying conditions and

Table 2

Conditions applied in pulping

Digester temperature	160°C	165°C	170°C
Digester pressure	5.5kg_f/ cm^2	5.5kg_f/ cm^2	5.5Kg_f/cm^2
Time to temperature	2hr10min	2hr10min	2hr10min
Time at temperature	1hr30min	1hr30min	1hr30min
Soda charged (%)	12, 16, 20	12, 16, 20	12, 16, 20
Anthraquinone (%)	0.05	0.05	0.05
Bath ratio	1:5	1:5	1:5

Table 3

Results of soda – AQ pulping

Temperature	160°C			165°C			170°C		
Soda charge (%)	12	16	20	12	16	20	12	16	20
Kappa number	34.4	25.9	22.5	32.2	25.1	21.8	30.8	24.6	21.2
RAA (gpl)	0.00	0.79	1.1	0.00	0.95	1.6	0.00	1.2	1.7
Screened yield (%)	31.2	37.30	42.16	32.08	39.2	43.12	33.5	39.8	44.1
Viscosity (cps)	14.0	11.8	11.1	13.9	11.4	10.9	13.7	11.6	10.7
Unbleached pulp brightness (%ISO)	30	31.9	33.1	30.2	31.5	33.2	31.2	32.5	34.2

Table 4

Conditions for oxygen delignification

O_2 pressure	6.5 kg_f/cm^2
NaOH	2.5%
$MgSO_4$	0.2%
Consistency	10%
Temperature	100°C
Time	60 min

Table 5

DEDP Bleaching sequence conditions

Stage	D_1	E	D_2	P
Temperature (°C)	60°C	65°C	60°C	70°C
Consistency	10%	10%	10%	10%
Time	3hr	1hr	3hr	3hr
End pH	10	10	10	10
Chemical charge	70% of the chlorine demand	NaOH(%) = 0.6 times Cl_2 demand in D stage	30% of the chlorine demand	H_2O_2 = 0.3% $MgSO_4$=0.05% NaOH=2%

brightness of all the bleached pulps were evaluated as per BIS-1848 specifications (Table 6).

RESULTS & DISCUSSION

The main aim of the present investigation was to study the effects of different pulping variables on the brightess development in DEDP elemental chlorine free bleaching of whole jute. Effect of soda dose on unbleached pulp kappa number at different cooking temperatures have been shown in Fig.1. Kappa number was significantly reduced upon increasing soda dose from 12 to 20%. Fig.2 shows the effect of soda dose on screened pulp yield. With increase in temperature yield increased with increase in soda dose.

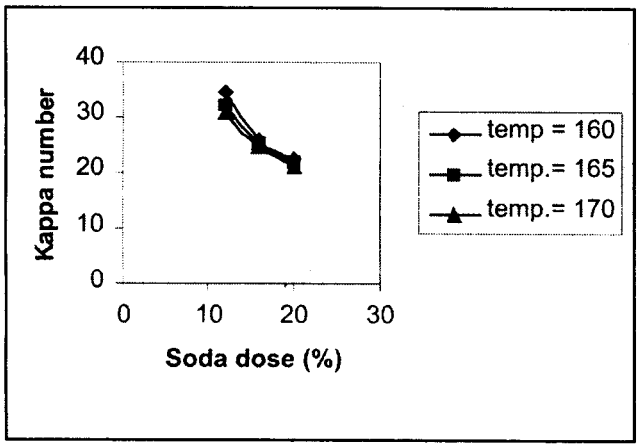

Fig. 1 Effect of soda dose on kappa number of unbleached pulp

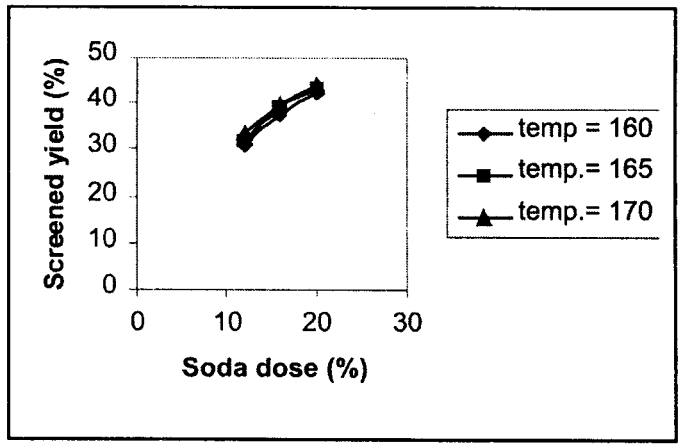

Fig. 2 Effect of soda dose on screened pulp yied

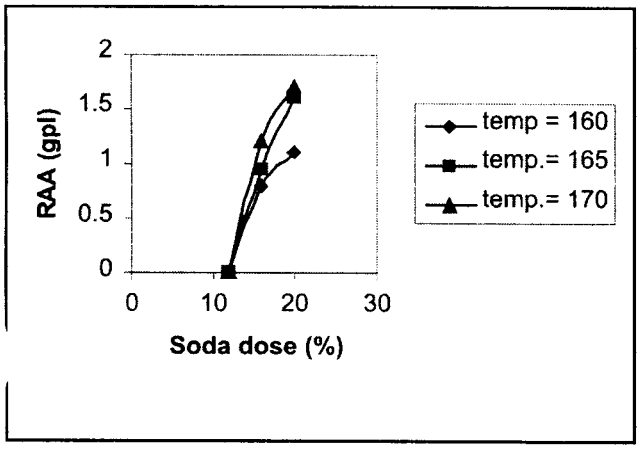

Fig. 3 Effect of soda dose on RAA

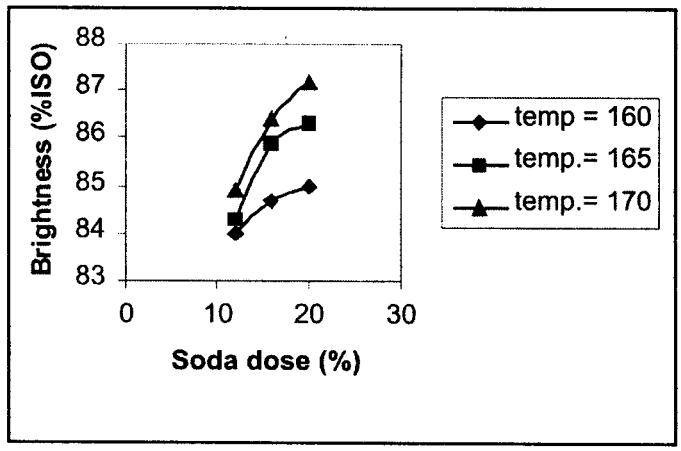

Fig. 4 Effect of soda dose on final brightness of pulp

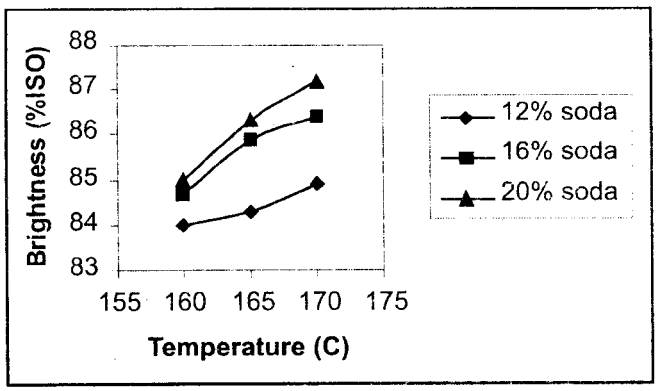

Figure 5 Effect of cooking temperature on final brightness of pulp

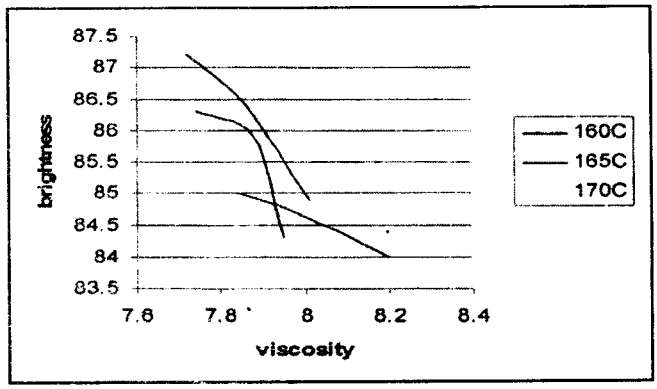

Figure 6 Effect of viscosity on the pulp brightness at various pulping

From Fig.3 it can be seen that residual active alkali increases sharply with increase in soda dose and it is maximum in case of 20% soda dose. Effect of soda dose on final brightness development has been shown in Fig.4. With increase in soda dose brightness increases sharply with increasing cooking temperature. But beyond 165°C the rate of increase in brightness gradually decreases. From Fig. 3 and 4 it can also be concluded that in case of higher RAA level, pulp can be bleached to higher brightness. Fig.5 shows the variation of pulp brightness with cooking temperature. For all levels of soda dose brightness increased significantly with increase in temperature. Effect of viscosity on the pulp brightness at various pulping temperature has been shown fig. 6. However it is move prominent for pulp with for higher brightness.

CONCLUSIONS

From the present experimental investigation it can be concluded that whole jute pulp obtained by soda – AQ pulping process and followed by oxygen delignification shows very good response to DEDP bleaching sequence to get higher brightness pulp suitable for writing and printing grades of paper. Within the domain of the present study, increasing the soda dose and cooking temperature resulted in increase in pulp brightness. The viscosity of the pulp decreased with increase in pulp brightness.

REFERENCES

1. Hurter R. W. , "Nonwood plant fiber uses in paper making, agricultural residue", TAPPI Short course notes, 53 (2001).

2. Kerr A.J., "Whole jute semichemical pulp as a reinforcing pulp for unbleached kraft paper", APPITA Jl., .24(3), 18 (1970)

3. Gupta H.K., Shivhare, P. and Mohindru V. K.,"Suitability of whole jute plants over other conventionally usednon-woody raw materialsfor paper and newsprint", IPPTA Jl., 10 (3),112 (1998).

4. Bhowmic K., "Dissolving pulp from jute stem (Chorchorus Capsularies) by water prehydrolysis kraft process", IPPTA Jl., 11 (1), 51 (1999).

5. Kleinert T. N., "Suitability of whole jute CMP for newsprint", TAPPI Jl., 49(2), 53 (1966).

6. Shah A. M., "Morphological characteristics of different non-wood fibers", IPPTA J., 3(2), 62 (1991).