High Brightness Pulp From Whole Jute

*Rawat N., *Kishore H., *Endlay N., *Roy T. K., & *Pant R.

ABSTRACT

Of the total paper consumed in the country, 55% is of cultural varieties and rest 45% is of industrial varieties of paper. The consumption of speciality grades of paper at present is very low but their demand is rising faster than the cultural grades of paper and with greater economic development their consumption will increase mainifold infuture. The paper highlights how superior quality pulp having high brightness (+88.0% ISO) and high strength can be produced from whole jute. Bleaching with oxygen and various bleaching chemicals like chlorine, chlorine dioxide and hypochlorite was performed to achieve target brightness at higher pulp intrinsic viscosity. Higher brightness pulp from whole jute could be produced by three bleaching sequences viz., D/C—E_o—$H_{1\cdot0}$, D/C—E_o—$D_{3\cdot0}$ and D/C—$E_{op}D_{3\ 0}$. All the bleached pulps showed fairly good intrinsic viscosity. D/CE_o—$H_{1\cdot0}$ sequence is the most economical and least polluting of the three sequences. A comparison with eucalyptus kraft pulp showed that the unbleached whole jute kraft pulp has higher intrinsic viscosity (992 Cm^3/g) than unbleached eucalyptus pulp (760 Cm^3/g) at comparable kappa number. It showed better bleachability than eucalytus pulp It could be bleached in shorter 3—stage bleaching sequence i e. D/C—E_o—$H_{1\ 0}$ compared to eucalyptus pulp which required 4—stage bleaching i e. D/C—E_{op}—$H_{1\cdot0}D_{2\ 0}$ to attain same value of brightness (+88.0% ISO). Bleached jute pulp showed higher viscosity (632 Cm^3/g) as compared to bleached eucalyptus pulp (490 Cm^3/g).

Introduction :

With rapid industrialization and economic development, the consumption of all varieties of paper i.e. cultural, industrial, packaging & newsprint will increase to a great extent in the coming years in the country. A recent survey has shown that in 1992 the consumption of paper amounted to 2.8 million tonnes corresponding to about 3.2 Kg. per capita consumption. The demand for paper board and newsprint is expected to rise to 4.6 million tonnes by the turn of century and further increase to 6.9 million tonnes by 2010 A.D[1] Present consumption pattern indicates that of the total paper consumed 55% is of cultural varieties (i e w/p, poster, coated etc.) and rest 45% of packaging and industrial varieties. Though the domestic demand for ordinary varieties of paper is somehow being met by the local production but some speciality papers like xerographic papers, x-ray interleving, ultra light weight coated, thin ptg. papers, self adhesives papers etc. are being presently imported. Besides, this sizeable amount of waste paper and wood market chemical pulp are also being imported which is used, as reinforcement fibres in varying proportions by both agro and forest based units. Also mechanical pulp is being imported for various end usage. In 1992, out of the total pulp consumed, 5% was imported market wood pulp and 15% imported waste paper resulting in expenditure of valuable foreign exchange, which the country can ill-afford to spend. Import of different grades of wood pulp & waste paper during the last decade is shown below.

*Central Pulp And Paper Research Institute
P. O. Box No, 174
Saharanpur-247 001 (U. P.)

Import of Different Grades of wood Pulp and Waste Paper and Boards

(in Tonnes)

YEAR	Mechanical wood pulp	Chemical wood pulp	Dissolving grade wood pulp	Pulps others	Waste Paper, waste board& scrap papers
1981—82	24,203	25,988	21,060	106	18,735
1982—83	20,929	16,220	15,508	932	32,675
1983—84	48,608	33,825	34,513	3,437	143,107
1984—85	72,591	45,495	14,942	16,065	253,797
1985—86	126,712	79,051	43,963	44,637	256,628
1986—87	108,780	13,752	12,277	64,644	295,389
1987—88	58,407	123,819	67,114	1,002	209,290
1988—89	22,147	112,600	36,456	3,213	181,857
1989—90	20,995	103,301	41,140	8,381	284,261
1990—91	44,841	150,504	88,596	7,502	385,199
1991—92	25,028	89,796	34,172	9,840	226,654

New developments in printing technology have revolutionised this industry worldover. The scenario has changed rapidly from letter press to offset to laser printing and every day newer innovation are being carried in this area in order to meet the requirements of modern society. This has resulted in great demand for superior quality i.e. high strength & brightness papers like fax papers, computer stationery, copier paper, higher gsm board papers, etc. Their demand is rising faster than the cultural grades of paper. There is a sizeable consumption of high grade quality paper in the industrialized countries. The papermakers abroad find it a more profitable proposition to produce and market this grade of paper more so in the recent years, with the paper units registering low return on investment and stricter pollution laws forcing the industry to spend a sizeable amount of money in pollution abatement programmes or using other process which may be expensive but less polluting. As compared to the developed countries the consumption of speciality grades of paper in our country is very low or can be said to be almost negligible at present. But as mentioned earlier with greater economic developments, the r consumption is bound to increase manyfold. It will then be a co tly affair to import the sizeable amount of this grade of paper.

With this overall picture of production of different grades of paper, serious efforts should be undertaken right now to make genuine improvements in the quality and strength of paper being produced in the country. Process technologies should be updated/ improved to make acceptable quality of paper without depending upon the blend with imported soft wood pulp which will save foreign exchange to some extent. Also the Indian paper industry should keep abreast with the global trends and forsee the prospective growing demand of new varieties of paper. Sincere moves should be made to start production of these profitable grades of speciality papers since their demand is rising faster than the cultural grades of paper. Jute[2], kenaf[3-5], cotton linters etc. whose paper making potential is already established can replace to some extent imported kraft pulp and paper for making better grades of paper. In the recent decades the capaturing of gunny industry by the plastic industry, a huge amount of jute has become surplus. This jute can be used as a raw material for making different grades of paper. Efforts were initiated in CPPRI on the utilisation of whole jute for different grades of pulp by most economic process. The paper highlights the use of whole jute for making high brightness. & strength pulp which can be utilized for various end product production.

Experimental :

Unbleached kraft pulp from whole jute was obtained in the laboratory by cooking the raw material with 17% Active alkali as Na_2O at 20% sulphidity for 90 minutes at 165°C. After screening, dry content of the pulp was determined and the pulp was evaluated for kappa number, viscosity and brightness.

This unbleached screened pulp was taken for further experiments on extended delignification using oxygen and bleaching by different bleaching chemicals.

Extended Delignification :

Extended delignification of unbleached pulp (of 23 4 kappa) was carried in laboratory series digester at 120°C for 60 minutes at 10% consistency. The oxygen pressure during the reaction was 4.0 Kg./cm^2. The pulp was then evaluated for kappa number, viscosity and brightness and subjected to bleaching experiments.

Bleaching :

Unbleached pulp was bleached by different bleaching sequences as given below :

CEH, CED, D/C–E_o–H, D/C–E_o–D, D/C–E_{op}–D, O–D/C–E–D, O–D/C–E–H, O–C–E–H.

The bleached pulps were analysed for viscosity & brightness. COD of bleach effluent was also determined.

Chlorination / D/C Stage.

5 0% and 2 0% chlorine as available chlorine was applied on unbleached whole jute (23.4 kappa no.) and O_2 deliginified whole jute pulp (10.3 kappa number) respectively. In D/C stage 20% of chlorine charge in chlorination stage was substitued with chlorine dioxide. Chlorine dioxide was added sequentially without washing in between. Temperature was ambient and consistency maintained at 3.0% for homogenous mixing.

Alkali Extraction Stage :

Alkali extraction was carried at 70°C for 60 minutes at 10% consistency. Sodium hydroxide dose used was 2% and 1% on O.D. pulp for unbleached and oxygen delignified whole jute pulp respectively.

In oxidative alkali extraction, 2 Kg/cm^2 of oxygen pressure was applied during extraction. Other conditions were kept constant as in alkali extraction stage.

In hydrogen peroxide reinforced oxidative extraction, 0.3% of H_2O_2 on O D. pulp was added at the conditions specified above.

Hypochlorite Stage :

Calcium hypochlorite bleaching was carried at 40°C for 120 minutes at 8% consistency. Different dose of hypo (1 to 3%) was applied on O D. pulp in order to achieve target brightness of + 88% ISO in different bleaching sequences.

Chlorine Dioxide Stage :

Chlorine dioxide stage bleaching was carried at 70°C for 180 minutes at 8% consistency. Varying dose of chlorine dioxide as available chlorine (1 to 3%) was applied on O.D. pulp in order to achieve target brightness of + 88% ISO.

Chlorine dioxide was prepared in laboratory by using potassium chlorate, oxalic acid and sulphuric acid according to method as described in laboratory manual[6].

Kappa Number :

Kappa number of unbleached pulps was determined according to Tappi standard method T 236 OS 76.

Pulp Viscosity :

Intrinsic pulp viscosity of unbleached and bleached pulps was determined according to Scan method C 15 : 62.

Brightness :

Brightness of unbleached and bleached pulps was determined according to ISO 2470 standard method.

C O D :

COD of bleached effluents was determined according to Standard method for examination of Water and Waste Water, 16th Ed. APPHA, AWWAWPCF (NY).

TABLE—1

Bleaching of Whole Jute Pulp with C—E—H, C - E—D and O—C- E —H Sequences

Unbleached pulp Kappa No.	23.4
Unbleached pulp Brightness, % ISO	22.6
Unbleached pulp Intrinsic viscosity, cm^3/g	992
O_2 delignified pulp Kappa no.	10.3
O_2 delignified pulp Brightness, % ISO	44.4
O_2 delignified pulp Intrinsic viscosity, cm^3/g	849

S No.	PARTICULARS	C—E—H	C—E—D	O—C—E—H
1	**Chlorination stage :**			
	Chlorine as available chlorine applied/consumed, %	5.0/4 93	5.0/4.93	2.06/1.86
2	**Alkali Extraction :**			
a)	Sod. hydroxide applied, %	2.0	2 0	1.0
b)	pH start/end	11.5/11.1	11.3/11 0	11.·/11 0
c)	Brightness, % ISO	40.8	40 8	61 8
3	**Hypo/chlorine Dioxide stage :**			
a)	Ca. hypochlorite/ chlorine dioxide as available chlorine applied/consumed, %	1.0/1.0 2.0/1.9 3.0/2.8	1.0/1 0 2.0/2 0 3.0/2 9	1.0/0.76 1.5/1.26
b)	Sod. hydroxide applied, % as buffer to maintain pH	0.15 0.2 0.2	— — —	0.10 0.10
c)	pH start/end	10.6/9.0 10.6/8.6 10.8/8.7	3.8/4.0 3.5/3.4 3.5/3.4	10.1/9.2 10 5/9.0
4	Brightness, % ISO	77.7 81.9 83.2	55.2 64.0 70 1	83.6 84.0
5	Intrinsic viscosity,	630 ND 316.5	ND ND 890	727 ND
6	Total COD in bleach effluent Kg./ pulp	59.3 63.3 70.6	← ND →	26.8 ND

Constant Bleaching Conditions :

	Chlorination	Alkali Extraction	Hypo	Chlorine Dioxide	Extended Oxygen Delignification
Consistency, %	3.0	10.0	8.0	8 0	10 0
Temperature, °C	Ambient	70	40	70	120
Retention Time, min	40	60	120	180	60
Oxygen Pressure, Kg/cm^2	—	—	—	—	4.0

TABLE—2

Bleaching of Whole Jute Pulp with D/C-E_o-H, D/C-E_o-D, D/C-E_{op}-D, O-D/C-E-D & O-D/C-E-H Sequences.

S.No.	PARTICULARS	D/C-E_o-H	D/C-E_o-D	D/C-E_{op}-D	O-D/C-E-D	O D/C-E-H
1	D/C stage :					
a)	ClO_2 as available Cl_2 applied/consumed, %	1.0/1.0	1.0/1.0	1.0/1.0	0.41/0.41	0.41/0.41
b)	Cl_2 as available Cl_2 applied/consumed, %	4.0/3.71	4.0/3.71	4.0/3.71	1.6/1.47	1.6/1.47
2	Alkali Extraction :					
a)	Sod. hydroxide applied, %	2.0	2.0	2.0	1.0	1.0
b)	H_2O_2 applied, %	—	—	0.3	—	—
c)	O_2 pressure, Kg/cm^2	2.0	2.0	2.0	—	—
d)	pH start/ end	11.3/11.1	11.3/11.1	11.4/11.2	11.0/11.0	11.1/11.0
e)	Brightness, % ISO	55.3	55.3	62.1	66.0	66.0
3	Hypo/ chlorine Dioxide Stage:					
a)	Ca hypochlorite	1.0 2.0 3.0	1.0 2.0 3.0	1.0 2.0 3.0	1.0 2.0 3.0	0.5 1.0
	ClO_2 as available Cl_2 applied/consumed,%	0.77 1.2 1.6	1.0 2.0 2.9	1.0 2.0 2.9	1.0 1.8 2.6	0.5 0.92
b)	Sod. hydroxide applied % as buffer to maintain pH	0.2 .2 .2	— — —	— — —	— — —	0.10 0.10
c)	pH start/end	10.5 10.4 10.6	3.8 3.8 3.5	3.8 3.8 3.8	4.2 4.0 3.8	10.1 10.1
		8.4 8.5 8.5	4.0 3.6 3.2	4.0 3.6 3.6	4.0 4.1 4.0	8.9 8.7
d)	Brightness, % ISO	88.1 88.4 88.3	84.5 87.0 88.0	86.0 85.9 88.1	80.6 82.9 83.3	83.4 84.5
4	Intrinsic viscosity, cm^3/g	632 ND ND	ND ND 735.8	ND ND 748.5	ND 818 812	785 760
5	Total COD in bleach effluent, Kg/t pulp	43.6 44.7 47.8	55.1 65.0 51.5	67.3 81.6 73.9	ND 28.2 ND	26.0 27.5

TABLE—3

Comparison of Eucalyptus and Whole Jute Pulp Bleaching to High Brightness (+88.0%, ISO)

S.No.	PARTICULARS	EUCALYPTUS KRAFT PULP		WHOLE JUTE KRAFT PULP		
1	Unbleached pulp:					
a)	Kappa no.	21.8		23.4		
b)	Brightness, % ISO	26.6		22.6		
c)	Intrinsic viscosity, cm^3/g	760		992.0		
2	Bleaching sequence	$D_{1.0}/C_{4.0}$–$E_2(_o)P_{.3}$–$H_{1.0}$	$D_{1.0}/C_{4.0}$–$E_2(_o)P_{.3}$ $H_{1.0}$–$D_{2.0}$	$D_{1.0}/C_{4.0}$–$E_2(_o)$–$H_{1.0}$	$D_{1.0}/C_{4.0}$–$E_2(_o)$–$D_{3.0}$	$D_{1.0}/C_{4.0}$–$E_2(_o P_{.3}$ –$D_{3.0}$
3	Bleached pulp:					
a)	Brightness,%ISO	83.0	87.8	88.1	88.0	88.1
b)	Intrinsic viscosity, cm^3/g	—	490	632.0	735.8	748.5
4	Total chlorine as available chlorine used in bleaching	6.0	8.0	6.0	8.0	8.0
5	Total COD Kg./T pulp of bleach effluent	N.D.	N.D.	47.8	51.5	73.9

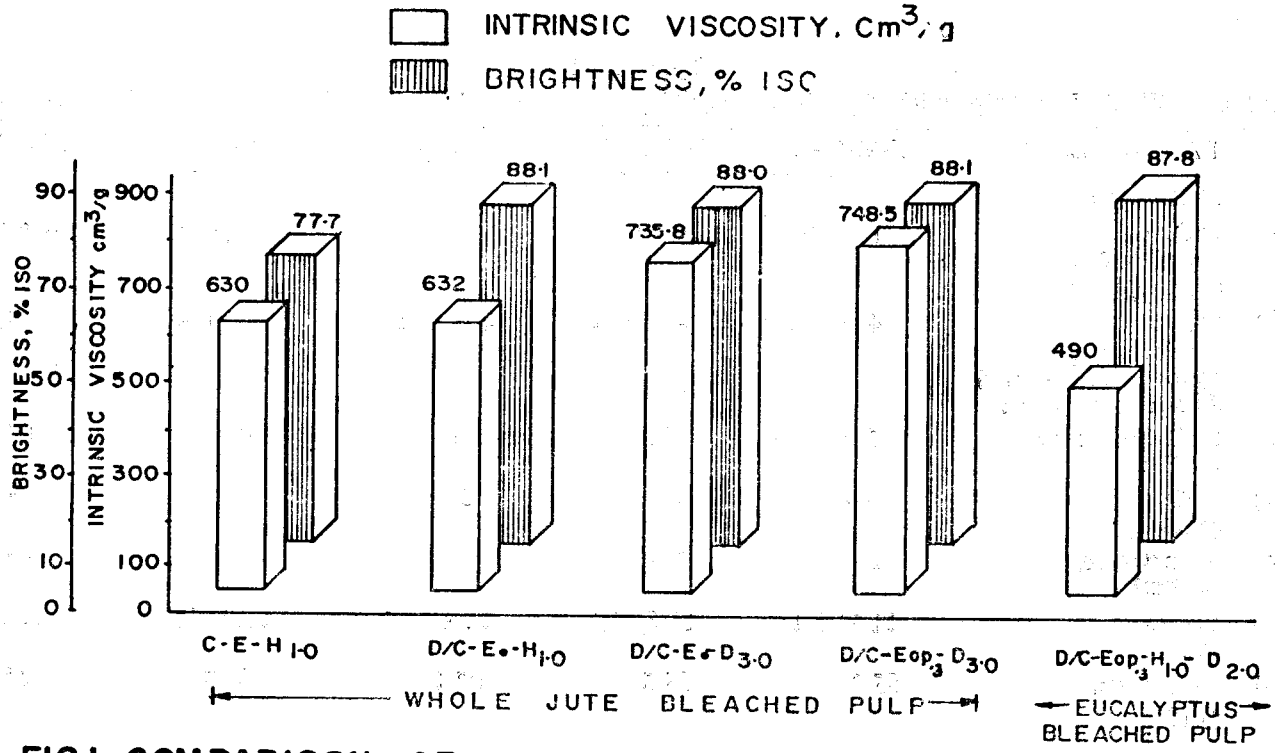

FIG.1, COMPARISON OF INTRINSIC VISCOSITY & BRIGHTNESS OF BLEACHED WHOLE JUTE PULP IN DIFFERENT BLEACHING SEQUENCES WITH EUCALYPTUS BLEACHED PULP.

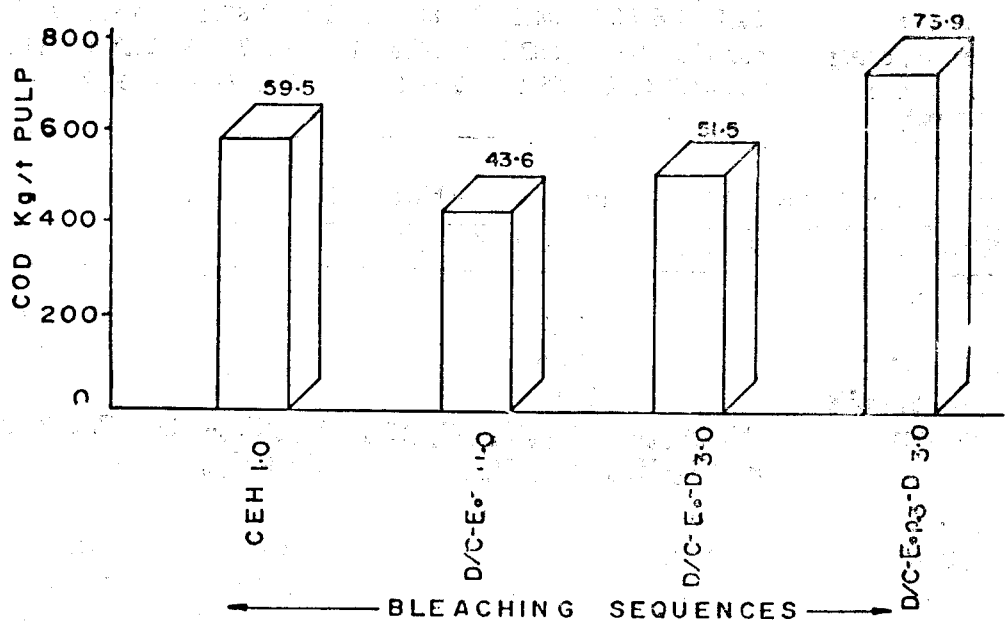

FIG.2, TOTAL EFFLUENT LOAD (COD Kg/t PULP) GENERATED IN BLEACHING OF WHOLE JUTE PULP BY DIFFERENT SEQUENCES.

Results and Discussion :

Table 1 indicates the results of pulp bleached by CED, CEH & O-CEH sequences. The CE bleached pulp has a brightness of 40.8% ISO. When bleached with varying dosage of chlorine dioxide (1-3% as available chlorine) brightness gain was found very poor. Even with 3% chlorine dioxide the maximum brightness obtained was 70 1% ISO only. However, when bleached with varying dosage of hypo (1.3% as available chlorine), it showed very good bleaching response. With only 1.0% hypo, the brightness achieved was 77.7% ISO. Higher dose (3%) of hypo resulted in further improvement in pulp brightness to 83 2% ISO but it was accompanied by marked drop in pulp viscosity. The pulp viscosity decreased from 630 to 316 5 cm^3/g on increasing hypo dose from 1% to 3.0%.

Extended delignification of unbleached pulp with oxygen, followed by CEH bleaching showed that O-CEH pulp has a brightness of 61 8% ISO which on

(Fig. 1) In D/C-E_o the pulp brightness was 55 3% ISO as compared to 40 8% ISO in case of CE pulps. Even higher brightness of 62 1% ISO was obtained in D/C-E_{op}-$_8$ pulp. In D/C-E_o-H sequence, brightness of 88.1% ISO could be achieved with only 1.0% hypo in final stage. While in other two sequences 3% chlorine dioxide (as available chlorine) was consumed to achieve the brightness of 88% ISO Pulp viscosities of chlorine dioxide bleached pulps were better than the D/C-E_o-H pulp (Fig. 1) However, D/C-E_o-H bleaching sequence is comparatively more economical. Also it generates lower pollution load of 43.6 kg/T pulp COD (Fig 2)

B'eaching of oxygen pretreated pulp followed by D/C-E-D and D/C-E-H sequences could not produce pulp of + 88% ISO brightness In case of O-D/C-E-D sequence a maximum brightness of 83% ISO was achieved with 2% chlorine dioxide (as available chlorine). Increasing the chlorine dioxide dose to 3% did not result in futher increase in pulp brightness.

Conclusions :

1. Unbleached whole jute kraft pulp has higher intrinsic viscosity (992 cm^3/g) compared to Eucalyptus kraft pulp (760 cm^3/g) of comparable kappa number.

2. Bleaching of whole jute kraft pulp by conventional CEH bleaching sequence, maximum brightness achieved is 83.2% ISO even by using very high dose of hypo (3.0% as available chlorine). This is however, accompanied with drastic drop in pulp viscosity.

3. Partial substitution of chlorine by chlorine dioxide in chlorination stage (20% of chlorine by chlorine dioxide as available chlorine) greatly enhances the bleachability of pulp in subsequent stages.

4. Brightness target of around 88% ISO was achieved with D/C-E_o-$H_{1\cdot0}$, D/C-E_o-$D_{3\cdot0}$ and D/C-E_{op}-$D_{3\cdot0}$ sequences.

5. Out of these, D/C-E_o-$H_{1\,0}$ bleaching sequence is the most economical and least polluting at comparable values of pulp brightness. However, it exhibits a little lower intrinsic viscosity value.

6. Whole jute pulp has better bleachability than eucalyptus pulp. It can be bleached in shroter 3-stage bleaching sequence i. e. D/C-E_o-$H_{1\cdot0}$ compared to Eucalyptus pulp which required 4-stage bleaching i e. D/C-E_{op} $H_{1\,0}$-$D_{2\,0}$ to attain same value of brightness (88% ISO).

7. Whole jute bleached pulp showed higher instrinsic viscosity (632 cm^3/g) as compared to eucalyptus bleached pulp (490 cm^3/g).

8. Whole jute is a promising raw material for producing high brightness and high strength pulp.

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