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21680

JUTE FOR INTERNATIONAL QUALITY SPECIALITY PULP

DG/IND/92/316

GOVERNMENT OF INDIA

FINAL REPORT
PHASE 1
JUTE PULPING

Prepared for the Government of India
by the United Nations Industrial Development Organisation,
acting as executing agency for the United Nations Development Programme

Based on the work of IVA, Linz, Austria
CPPRI, Saharanpur, India
TTD, Tribeni, India

Backstopping officer: R.M. Viegas Assumcao
Chemical Industries Branch

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IVA

TABLE OF CONTENT:

1. INTRODUCTION

The United Nation Development Programme (UNDP) in response to a request from the Ministry of Textiles, Government of India has approved the project DG/IND/92/316- - JUTE FOR INTERNATIONAL QUALITY SPECIALITY PULP-, as a part of the National Jute Programme. The implementing Agency is the Ministry of Textiles through the Central Pulp and Paper Institute (CPPRI), Saharanpur, in collaboration with the ITC Ltd. - Tribeni Tissue Devision /TTD), Calcutta.
UNIDO as cooperating Agency for the project engaged IMPCO - VOEST-ALPINE Pulping Technologies GmbH (IVA), Linz, Austria, as contractor, to provide services and perform the work for Phase I as described in the terms of reference for the subcontract envisaged by the project.

The services and work of IVA was carried out under the contract No. 94/028, Project DWG./IND.92/316 in collaboration with CPPRI and ITC Ltd.

4. SUMMARY OF TEST EXECUTION AND RESULTS

4.1 Jute pulping

Out of the known pulping processes the following were preselected as suitable for jute :
Kraft
Kraft-AQ
Soda
Soda-AQ
Alkaline-Sulphite
Alkaline-Sulphite-AQ

All of these pulping processes were tested in the laboratory and bleachability test were done to determinate the optimum pulping process and its condition.
After laboratory optimisation of all processes the final process **(KRAFT-AQ)**were selected and also tested in the pilot plant of CPPRI.
After modification of steam connections of one digester at Tribeni Mill a mill test were executed.
For details see Final test report phase 1a and 1b

4.1.1 Final pulping process

As a result of pulping tests the following process parameter can be used for jute bast fiber:

Pulping process: **Kraft-AQ**

Cooking condition:

Cooking temperature	**160 - 162 °C**
Heating up time	**Approx. 90 min**
Cooking time	**120 - 180 min**
AA charge	**12 - 14 % as Na_2O**
Sulfidity	**20 %**

With the simplest bleaching sequence C E H a brightness of 85 % relative could be achieved.
When adding peroxide in the extraction stage the final brightness increased to 87% relative with a reduced total chlorine consumption.
Using an oxygen delignification stage prior to the Chlorination stage improves the total chlorine consumption and the brightness result.(85 - 87 % relative)

Introducing chlorine dioxide instead of chlorine and hypo results in a brightness of 85 - 87 % relative. Using an oxygen delignification stage prior to the first chlorine dioxide stage (ODEoD) improved the total chlorine consumption and the relative brightness result is in the same range (85 - 87 %) as for sequence DED.

In case of total chlorine free bleaching with oxygen and peroxide the final brightness was 83 - 85 % relative. Introducing ozone in an total chlorine free bleaching sequence increased the final brightness up to 87 % relative.

For details see Final test report phase 1a and 1b

4.3 Jute pulp cleaning

After execution of all bleaching trials the available sample of pulp produced during the mill trials was cleaned and bleached.
The results show a cleaning efficiency of 66 % on brown stock. The final dirt content of C E H bleached pulp was about 9.5 mm^2/m^2.

This results indicate that dirt content of about 10 mm^2/m^2 can be achieved with proper screening and cleaning equipment.

For details see Final test report phase 1b Item 7.9 page 14 to 15

5. INCREASING THE ACTUAL PLANT CAPACITY:

According to the results of cooking trials at Tribeni Mill the cooking time with the tested jute fiber at a cooking temperature about 160°C can be reduced to max. 3 h.

That means that the actual cooking cycle can be reduced from 19 hours to 12,0-12,5 hours. The capacity increase on the digester plant would be approx. 52-58 % without any additional installation of blowing equipment. The capacity of digester would be 13680 - 14250 t/y.
In case of installing blowing equipment further time reduction of up to 5 hours are possible. In this case the total capacity increase on digester plant would be approx. 137 % and the final capacity would be 23400 t/y.
If similar raw material quality, as tested in the laboratory and pilot plant trials, is used, the total capacity of the digesting plant can be increased up to 27000 t/y.

For details see Final test report phase 1b item 7.11, page 17 to 18

6. CHEMICAL RECOVERY SYSTEM :

As the selected pulping process is Kraft-AQ a conventional sulphate recovery can be used.

This system consist of:

Evaporation plant
Recovery boiler
Recausticising plant
Lime reburning system (optional)

GENERAL PROCESS DESCRIPTION

The chemicals required for the cooking process are regenerated and thus reactivated after having been used in the digester. Chemicals losses in the cycle are made-up by the addition of caustic soda/sodium carbonate and sodium sulphate.

Black liquor from the pulp washing contains used pulping chemicals and dissolved organic substances. In the evaporation plant, black liquor is concentrated to approx. 45 % to 50 % by multiple-effect evaporation followed by a direct contact evaporator or concentrator to a dry solids content of about 60 %.

The thickened black liquor (strong black liquor) is burnt in the recovery boiler. The molten chemicals, mainly consisting of sodium carbonate and sodium sulphite as well as sodium sulphate, are discharged at the bottom of the furnace. The smelt flows out to the dissolving tank, where it is dissolved in weak white liquor (WWL) to make green liquor (GL), which is pumped to the recausticizing plant for white liquor preparation.

An electrostatic precipitator is installed to recover the valuable sodium chemicals from the flow gases. This is of great importance not only in chemicals recovery but also for controlling air pollution.

Part of the steam required for the process is provided by the recovery boiler. The rest of the steam is generated in a power boiler. The generated steam can also be used for power generation.

In the recausticizing plant green liquor is converted into an active cooking chemical - white liquor - for further use as cooking liquor.

Green liquor, primarily sodium carbonate is converted into caustic soda by using burnt lime. The white liquor contains crystallized calcium carbonate - lime mud - which is removed by clarification. The lime mud is washed with condensate from the evaporation plant, thickened again and stored in the lime mud storage tank. The filtrate is weak white liquor and is used in the dissolving tank.

Prewashed lime mud is pumped to a vacuum filter, dewatered and washed with hot water to remove sodium chemicals.

The lime mud can be reburnt to quick lime in a rotary lime kiln together with lime stone.

Due to the silica content of raw material some lime mud has to be discharged and replaced by fresh lime stone.

This final report for phase 1a replace the first and second interim report and all submitted preliminary reports.

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The services and work of IVA was carried out under the contract No. 94/028, Project DWG./IND.92/316 in collaboration with CPPRI and ITC Ltd.

In that agreement the objectives of the work were stated to be the determination of:

1. Conditions necessary to produce pulp from jute with the following processes:
   1. Kraft Pulping (Sulphate)
   2. Kraft AQ Pulping
   3. Soda Pulping
   4. Soda AQ Pulping
   5. Alkaline Sulphite Pulping
   6. Alkaline Sulphite AQ Pulping
   to reach a Kappa of 13+- 2 with Indication of yield results.

2. Selecting the optimum conditions of each process and repeating the cook,

3. Physical properties of the pulp produced under the optimum condition.

4. Bleachability of pulp produced under the optimum condition.

5. Pilot plant test at CPPRI with the selected final pulping process executed by CPPRI

6. Bleaching sequences using 2 chlorine-,2 ECF- and 2 TCF-sequences

7. Physical properties of bleached pulp

6. BENCH SCALE PULPING TESTS:

The following laboratory programme was carried out at IVA´ subcontractor Pulp & Paper Institute in Ljubliana, Slovenia to determinate the optimum pulping condition for jute bast fibre supplied by ITC Limited, TRIBENI TISSUE DIV, Calcutta, out of the selected processes.
Target for all tests was to reach a kappa number of 13+-2.
Cooking condition as well as Kappa number, yield, reject amount are presented for every cook.

6.1. Kraft Pulping (Sulphate) and Kraft AQ Pulping

In total 18 laboratory trials were carried out in a 10 l rotary digester with electric heating according to the Kraft process and Kraft AQ process with following parameter:

AA Charge as Na_2O	%	10	12	14
Sulfidity	%	20		
Heating up time	min	90		
Cooking time	min	60	120	240
Temperature	°C	150	160	165
AQ Charge	%	0,05		

After cooking and refining the pulp was washed over a Screen Mesh 16 and screened over a WFVERK membrane screen with screenplate`s opening: 0,15 mm.

The Kraft pulping tests with 12% AA and 160°C with and without AQ were repeated to verify the cooking results.

Details of cooks see table 1 to table 6 as well as figure 1 to figure 4.

Summary of the laboratory trials:

All tests show that the required AA-charge is about 12 % (as Na_2O) to get a Kappa about 13. In case of Kraft-AQ process the pulp yield was approx. 1% point higher than without AQ.
As high temperature would influence the mechanical properties of pulp and the low temperature would need a long cooking time the following parameter for the final pulping test was selected:

AA-charge	12 % as Na_2O
Sulfidity	20 %
Cooking temperature	160°C
Cooking time	2 hours
AQ-charge	0,05 % in case of Kraft-AQ Process

6.2. Soda and Soda AQ Pulping

In total 18 laboratory trials were carried out in a 10 l rotary digester with electric heating according to the Soda process and Soda AQ process with following parameter:

AA Charge as Na_2O	%	12	14	16
Heating up time	min	90		
Cooking time	min	60	120	240
Temperature	°C	150	160	165
AQ Charge	%	0,05		

After cooking and refining the pulp was washed over a Screen Mesh 16 and screened over a WFVERK membrane screen with screenplate`s opening: 0,15 mm.

Details of cooks see table 7 to table 12 as well as figure 5 to figure 8.

Summary of the laboratory trials:

All tests shows that the required AA-charge is about 14 % (as Na_2O)to get a Kappa about 13. In case of Soda-AQ process the pulp yield was approx. 1% point higher than without AQ and the AA-charge can be reduced by min. 0,5% point when using a cooking temperature of 160°C. As high temperature would influence the mechanical properties of pulp and the low temperature would need a long cooking time the following parameter for the final pulping test was selected:

	SODA	SODA-AQ
AA-charge	14 %	13,5 as Na_2O
Cooking temperature	160°C	
Cooking time	2 hours	
AQ-charge	-	0,05 %

6.3. Alkaline sulphite and Alkaline sulphite-AQ pulping

In total 8 laboratory trials were carried out in a 10 l rotary digester with electric heating according to the alkaline sulphite and alkaline sulphite-AQ process with following parameter:

NaOH Charge	%	2	2,5	4	8
SO_2 Equivalent	%	8	10	16	24
Na_2SO_3 Charge	%	15,75	19,69	31,50	47,25
Heating up time	min	90			
Cooking time	min	240			
Temperature	°C	165			
AQ Charge	%	0,05			

After cooking and refining the pulp was washed over a Screen Mesh 16 and screened over a WFVERK membrane screen with screenplate`s opening: 0,15 mm.

Details of cooks see table 13 to table 14 as well as figure 9 to figure 10.

Summary of the laboratory trials:

The tests show that alkaline sulphite pulping process with an NaOH /SO_2 ratio of 1:3 - 1:4 , a relative high chemical charge, a high temperature of 165° and a long cooking time of 4 hours could not achieve the desired kappa number. the lowest kappa number was 51,3 at an Na_2SO_3 charge of 47,25 %. With an addition of 0,05 % AQ the kappa number could be reduced to approx. 19.
As the target kappa could not be reached with alkaline sulphite process and the results of AQ addition brought kappa down to approx. 19, it was decided that only Alkaline sulphite final cooks with AQ-addition will be used for the final pulping test with the following parameter:

Na2SO3-charge	47,25 %	(24 % SO_2)
Cooking temperature	165°C	
Cooking time	4 hours	
AQ-charge	0,05 %	

6.4. **Final pulping tests** for determination of physical properties and bleachability tests.

In total 10 laboratory trials were carried out in a 10 l rotary digester with electric heating according to following parameter:

Process	AA charge as Na_2O (Na_2SO_3) %	Heating up time min	Digesting time min	Temp. °C
Kraft	12	90	120	160
Kraft AQ	12	90	120	160
Soda	14	90	120	160
Soda AQ	13,5	90	120	160
Alkaline sulphite	no final pulping tests			
Alkaline sulphite AQ	47,25 (= 24 % as SO_2)	90	240	165

Sulfidity for Kraft and Kraft-AQ pulping process = 20 %

After cooking and refining the pulp was washed over a Screen Mesh 16 and screened over a WFVERK membrane screen with screenplate`s opening: 0,15 mm.

Details of cooks see table 15a to table 19a

Physical properties of unbleached jute pulp see table 15b to table 19b

Fibre analysis see distribution analysis of unbleached jute pulp

Physical properties of each unbleached jute pulp see figure 11 to figure 15

Fibre length unbleached jute pulp see figure 16

Coarseness unbleached jute pulp see figure 17

Slenderness factor unbleached jute pulp see figure 18

Zero span tensile unbleached jute pulp see figure 19

Physical properties unbleached jute pulp at 50 SR see figure 20 to figure 27

Physical properties unbleached jute pulp at 30 SR see figure 28 to figure 33

Viscosity of unbleached jute pulp see figure 34

6.5. Summary of the laboratory trials:

All tests verify the selected pulping conditions.

For the selection of final process to be tested in the pilot plant of CPPRI the following matrix was prepared:

Process	Kraft	Kraft -AQ	Soda	Soda -AQ	Alkaline-Sulphite -AQ
Kappa number	3	2	4	1	5
Chemical consumption	2	1	4	3	5
Energy consumption	2	1	4	3	5
Chemical recovery	2	1	4	3	5
Yield unbleached	3	2	5	4	1
Viscosity unbleached	3	2	3	4	1
Bleaching chemical consumption *	4	2	3	1	5
Dirt content bleached *	3	2	1	5	4
Breaking length at 30 SR	2	1	4	5	3
fibre length	2	2	3	1	2
Fibre strength	3	2	2	4	1
Slenderness factor	3	2	4	1	5
Total	33	21	44	39	47

*) From the bleachability test results

Note:			
	1	=	Excellent
	2	=	Very gut
	3	=	Good
	4	=	Sufficient
	5	=	Insufficient

From this matrix the pulping processes can be ranged as follow:
1. Kraft-AQ
2. Kraft
3. Soda-AQ
4. Soda
5. Alkaline sulphite

8. BENCH SCALE AND PILOT PLANT TRIALS AT CPPRI IN SAHARANPUR

The following laboratory programs were carried out at CPPRI laboratory and pilot plant to check the results obtained at IVA´ subcontractor Pulp & Paper Institute in Ljubliana, Slovenia for jute bast fibre supplied by ITC Limited, TRIBENI TISSUE DIV, Calcutta.
Target for all tests was to reach a kappa number of 13+-2.
Cooking condition as well as Kappa number are presented for every cook.

8.1. Kraft Pulping (Sulphate) and Kraft AQ Pulping

The **laboratory trials** were carried out in a 2.5 l rotary digester with electric heated immersion oil bath according to the Kraft process and Kraft AQ process with following parameter:

AA Charge as Na_2O	%	12	12
Sulfidity	%	20	20
Heating up time	min	90	90
Cooking time	min	120	120
Temperature	°C	160	160
AQ Charge	%	0,00	0,05

Details of cooks see table 25 to table 26

The **pilot plant trials** were carried out in a cylindrical rotary digester (Size = 11 m^3)with direct steam heating according to the Kraft process and Kraft AQ process with following parameter:

AA Charge as Na_2O	%	12	11.5	12	12	11.5
Sulfidity	%	20	20	20	20	20
Heating up time	min	90	90	90	90	90
Cooking time	min	120	120	180	240	120
Temperature	°C	160	160	160	150	160
AQ Charge	%	0,00	0,00	0,05	0,05	0,05

After cooking the pulp was blown in an blow tank and washed on an belt washer.

Details of cooks see table 27 to table 32

Summary of the laboratory and pilot plant trials:

All the tests at the laboratory and pilot plant of CPPRI as well as tests at Tribeni Tissue Laboratory confirm the cooking results of IVA.

AA-charge	12 % as Na_2O
Sulfidity	20 %
Cooking temperature	160°C
Cooking time	2 hours
AQ-charge	0,05 % in case of Kraft-AQ Process

See figures 81 to 92

Pulp produced during the Pilot plant tests at CPPRI was blown in a blow tank at different pressure without any problem.

Additional trial was carried out at SHAMLI Paper Mill (located near to Saharanpur) in a spherical digester with soda-AQ process to confirm the blow ability of jute pulp not only from a cylindrical digester with conical bottom but also out of a spherical digester.

The result of this trial is:

Jute pulp at the processed Kappa No. can be also blown from a spherical digester ! ! !

9. BENCH SCALE BLEACHING TRIALS

The following laboratory programme was carried out at IVA´ subcontractors Pulp & Paper Institute in Ljubliana, Slovenia and ÖHFI in Vienna to determine the bleachability of the pulp produced in the pilot plant at CPPRI under the pre scribed conditions to support the selection of the final bleaching process to be used at Tribeni mill, India.
The bleaching tests were carried out with the sequences

C - E - H

C - Ep - H

O -C - EO - H

D - E - D

O -D - EO - D

O -A - EOP - P / O -Q - EOP - P

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

During the execution of the bleaching tests it was found that IVA-Laboratories used for the brightness measurement the absolute value and Tribeni mill the relative value so that all results of IVA have to be increased by approx. 2 % points to get comparable results to Tribeni mill.

A = Acidification stage

C = Chlorination stage

D = Chlorine dioxide stage

E = Extraction stage

EO = Extraction stage with addition of oxygen

EOP = Extraction stage with addition of oxygen and peroxide

EP = Extraction stage with addition of peroxide

H = Hypo stage

O = Oxygen delignification

P = Peroxide stage

Q = Chelation stage

Z = Ozone stage

9.7 O - A - Z - P / O - Q - Z - P bleaching:

The target brightness for this sequence was 84-85 %.

In total 3 laboratory bleaching trials were carried out.

The final results of brightness measurement was :

84,8-87,3 % ISO	absolute
86,8-89,3 %	relative

Details of bleaching parameter and results see table 46

9.8 Quality of unbleached pulp:

During the bleaching trials it was founded that a part of the pulp sent by air fright and submitted throw IVA to the Pulp and Paper Institute in Ljubliana was deteriorated and have to be separated from the good pulp to avoid further degradation.
This was one of the reasons whey this institute felt to achieve the target brightness in some of there tests.

Table 33 and 34 shows the physical properties of both kind of pulp.

9.9 Summary of bleaching trials:

Generally the bleaching results were in an acceptable ranges.

With the simplest bleaching sequence C E H a brightness of 84,8 % relative could be achieved.
When adding peroxide in the extraction stage the final brightness increased to 87,2 % relative with a reduced total chlorine consumption.
Adding an oxygen delignification prior to the chlorination stage improve the total chlorine consumption.

Introducing chlorine dioxide instead of chlorine and hypo results in a brightness of 87 % relative. Adding an oxygen delignification prior to the first chlorine dioxide stage improve the total chlorine consumption.

In case of total chlorine free bleaching with Oxygen and peroxide the final brightness was 84,7 % relative. Introducing ozone in an total chlorine free bleaching sequence increased the final brightness up to 89,3 % relative.

See table 47 and figures 101 to 129 and the following table !

10.3 Bench scale and pilot plant pulping tests at CPPRI

TABLE 34

Physical properties of unbleached pulp produced in the pilot plant with Kraft-AQ pulping process prepared for bleaching tests

Messured at : **Pulp and Paper Institute, Ljubliana, Slowenia**

Sample from Pilot plant test No. PP04

		Deteriorated pulp sample					
with PFI mill							
Beating point	-	0	1	2	3		
PFI revolution	rpm	1450	1450	1450	1450		
	rev.	0	4350	7250	11600	6042	9860
	min	0,00	3,00	5,00	8,00	4,17	6,80
Freeness	SR	16	23	35	60	30	50
	CSF	680	535	366	151	428	224
Grammage	g/m²	73,45	75,45	71,97	73,56	73,42	72,92
Thickness	mm	0,183	0,137	0,119	0,158	0,127	0,142
Density	kg/m³	434	515	605	681	568	651
Bulk	m³/kg	2,304	1,810	1,530	1,468	1,647	1,493
Stretch	%	1,1	2,5	2,9	3,3	2,7	3,1
Breaking length	m	1497	3862	4525	4612	4249	4577
Burst strength	kPa	56	177	198	214	189	208
Tearing resistance	mN	838	871	643	562	738	594
Tensile index	Nm/g	14,69	37,89	44,39	45,24	41,68	44,90
Burst index	kPam²/g	0,76	2,35	2,75	2,91	2,58	2,85
Tear index	mNm²/g	11,41	11,54	8,93	7,64	10,05	8,15
Bendtsen porosity A/B side	ml/min				363	0	218
Bendtsen smoothness A/B side	ml/min		575	428	325	489	366
Scattering coefficient		237	216	217	214	217	215
Opacity	%	97,80	98,10	97,70	97,14	97,87	97,36
Zero beaten pulp:							
Fibre length Arithmetic average	mm	1,13					
Fibre length weighted average	mm	1,55					
Fibre diameter	mm						
Coarseness	mg/m	0,172					
Slenderness factor		9,0					
Fibre fraction Bauer McNett:							
retained on mesh 14	%	85,1					
retained on mesh 30	%	6,4					
retained on mesh 50	%	2,0					
retained on mesh 100	%	1,3					
going through mesh 100	%	5,4					
Viscosity	ml/g	669					

1. INTRODUCTION

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The services and work of IVA was carried out under the contract No. 94/028, Project DWG./IND.92/316 in collaboration with CPPRI and ITC Ltd.

In that agreement the objectives of the work were stated to be the determination of:

1. Mill scale trials to produce pulp from jute with the following process:
   Kraft AQ Pulping
   with a target Kappa of 13+- 2.

2. Testing the physical properties of the pulp produced during the mill trial.

3. Bleaching of pulp produced during the mill trial.

4. Testing the physical properties of bleached pulp

5. Recommendation for increasing jute pulp production from 9000 to 15000 tpy within the existing plant and facilities.

5. PULPING EQUIPMENT:

Used at Tribeni Tissue Mill:

Digester: Spherical rotary

Diameter	m	4.3
Volume	m^3	40

Wash beater: Type Hollander

Screening and Cleaning:

only vibrating screen and centricleaner were in operation Other available equipment as Pressure screens were out of order.

Brown stock filter washer:

Type Hindustan Dorr Oliver

Drum size:

Diameter	cm	243,8
Face length	cm	243.8
Wire cloth	mesh	40x36

Consistency:

Inlet	%	1,0
Outlet	%	10,0

6. MILL SCALE PULPING TESTS:

The test program was carried out at TRIBENI TISSUE Mill to produce pulp with a target Kappa about 13+-2.
Cooking condition as well as Kappa number, yield, reject amount are presented for every cooks.
After the execution of bench scale pulping tests and pilot plant trials the program for the mill trials was discussed and as follow agreed by CPPRI, Tribeni and IVA:

Cooking Process:	Kraft-AQ
Cooking Temperature:	160 °C
Heating up time	90 min
Cooking time	min 120 min
AA-Charge	min 12 % as Na_2O
Sulfidity of cooking liquor	20 %

As the existing digesters are using low pressure steam and there are no medium pressure steam lines available in the fibre line Tribeni decided to install a new line for medium pressure steam to one digester where the tests were executed.
This works were completed in December 1995.

On 4.01.1996 Tribeni started cooking jute in the digester with modified steam connection.
IVA representative Mr. Naga arrived on 22.01.1996 at Tribeni mill and conducted the tests together with Dr. Behera and his team.
Representative of CPPRI, i.e. Mr. H.K. Dhingra, Mr. Promod Pade were also present during the final mill scale pulping trial.

The raw material had a different quality than the previous tested one. Therefore the required AA-charge was higher than tested at IVA laboratory ,CPPRI pilot plant and TTD laboratory. The quality of fiber and the high hard bark content are the reasons why this material consumed more alkali and required minimum 180 min cooking time.

During the tests we tried to optimise cooking condition not only to reach the kappa No. but also to get uniform cooked pulp with low shives content.

Cooking time reduction to 150 min or reducing the AA-charge by 0,5 % results in high shives content in pulp after breaker beater.

The final test for bleaching trials was executed on 29/30.01.1996 with the following parameter:

Raw material to digester	6850 ADkg
AA-charge	13,86 % on BDMT of raw material as Na_2O
	12,47 % on ADMT of raw material as Na_2O
Cooking time	180 min
Cooking temperature	160-163 °C
H-Factor	1600

The cooking results are:

		measured at Ljiubliana	Vienna	Tribeni
Kappa Number		11,5	11,5	12,0
Limited Viscosity	ml/g	1088	1147	
1% Cuoxam,20°C	cps			105
Brightness	% ISO		34,7	
Fiber length	mm	1,75		1,65
Coarseness	mg/m	0,173		0,128
Slenderness Factor		10,1		12,89
Mechanical properties at 50 SR:				
Breaking length	m	7393		9051
Stretch	%	3,9		3,43
MID double fold		1739		
Tensile index	Nm/g	72,52		88,79
Burst index	kPam²/g	5,06		5,8
Tear index	mNm²/g	13,27		13,43
Bendtsen porosity	ml/min	205		101
Bendtsen smoothness	ml/min	771		712
Scattering coefficient	m²/kg	17,4		
Opacity	%	98,01		

Details of cooks see table 49

Comparison of cooking results for lab. pilot and mill tests see figures 140 to 145.

Physical properties of unbleached jute pulp see table 50

Fibre analysis see distribution analysis of unbleached jute pulp

7. BENCH SCALE BLEACHING TRIALS

The following laboratory programme was carried out at IVA´ subcontractors ÖHFI in Vienna and Pulp & Paper Institute in Ljubliana, Slovenia to determinate the bleachability of the pulp produced in the Tribeni Mill under the pre scribed conditions to support the selection of the final bleaching process to be used at Tribeni mill, India.
The bleaching tests were carried out with the sequences

C - E - H

C - Ep - H

O -C - EO - H

D - E - D

O -D - EO - D

O -A - EOP - P / O -Q - EOP - P

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

A = Acidification stage

C = Chlorination stage

D = Chlorine dioxide stage

E = Extraction stage

EO = Extraction stage with addition of oxygen

EOP = Extraction stage with addition of oxygen and peroxide

EP = Extraction stage with addition of peroxide

H = Hypo stage

O = Oxygen delignification

P = Peroxide stage

Q = Chelation stage

Z = Ozone stage

7.8 Summary of bleaching trials:

Generally the bleaching results are in an acceptable ranges and confirm the previous test results.

With the simplest bleaching sequence C E H a brightness of 85,2 % relative could be achieved.
When adding peroxide in the extraction stage the final brightness increased to 87,2 % relative with a reduced total chlorine consumption.
Adding an oxygen delignification prior to the chlorination stage improves the total chlorine consumption and the brightness result.

Introducing chlorine dioxide instead of chlorine and hypo results in a brightness of 84,8 % absolute. Adding an oxygen delignification prior to the first chlorine dioxide stage improves the total chlorine consumption and the brightness result.

Chlorine dioxide consumption of 65 kg/t of pulp (as active chlorine) in a D-E-D bleaching sequence is very high compared to 29 kg/t of pulp for chlorine and hypo consumption in a C-E-H bleaching sequence. That means that chlorine is much more efficient than chlorine dioxide for jute pulp bleaching.

In case of total chlorine free bleaching with oxygen and peroxide the final brightness was 83,4 % relative. Introducing ozone in an total chlorine free bleaching sequence increased the final brightness up to 87,2 % relative.

See table 58 and figures 151 to 177.

Fibre analysis see distribution analysis of bleached jute pulp

Summary of Bleaching test-results for kraft-AQ Jute pulp produced in pilot plant and mill trials with comparison to the targeted figures

SEQUNCE	Brightness absolute % ISO		Brightness relative %		Limited Viscosity ml/g		Break.length at 50 SR Km		Coarseness mg/m		Slenderness factor	
	target	reached	target	reached	target	reached	target	reached	target	reached	target	reached
C-E-H	82	83	84	85	600-800	550-800	6,7	6,5-6,9	0,105	0,10-0,17	16,0	10-17
C-EP-H	84	85	86	87	600-800	550-700	6,7	6,5-6,7	0,105	0,10-0,15	16,0	11-17
O-C-EO-H	84	83-85	86	85-87	600-800	650-800	6,7	6,0-6,6	0,105	0,12-0,15	16,0	11-12
D-E-D	85,5	83-85	87,5	85-87	600-800	900-1050	6,7	6,5-7,9	0,105	0,10-0,11	16,0	14-15
O-D-EO-D	86	82-85	88	84-87	600-800	800-900	6,7	6,6-7,0	0,105	0,13-0,16	16,0	9-13
O-A-EOP-P	82-83	81-83	84-85	83-85	600-800	650-850	6,7	6,8-6,9	0,105	0,11-0,12	16,0	12-15
O-A-Z-P	82-83	85-87	84-85	87-89	600-800	500-600	6,7	5,5-5,6	0,105	0,11-0,12	16,0	11-13

4.3 Jute pulp cleaning

After execution of all bleaching trials the available sample of pulp produced during the mill trials was cleaned and bleached.
The results show a cleaning efficiency of 66 % on brown stock. The final dirt content of C E H bleached pulp was about 9.5 mm^2/m^2.

This results indicate that dirt content of about 10 mm^2/m^2 can be achieved with proper screening and cleaning equipment.

For details see Final test report phase 1b

5. INCREASING THE ACTUAL PLANT CAPACITY:

According to the results of cooking trials at Tribeni Mill the cooking time with the tested jute fiber at a cooking temperature about 160°C can be reduced to max. 3 h.

That means that the actual cooking cycle can be reduced from 19 hours to 12,0-12,5 hours. The capacity increase on the digester plant would be approx. 52-58 % without any additional installation of blowing equipment. The capacity of digester would be 13680 - 14250 t/y.
In case of installing blowing equipment further time reduction of up to 5 hours are possible. In this case the total capacity increase on digester plant would be approx. 137 % and the final capacity would be 23400 t/y.
If similar raw material quality, as tested in the laboratory and pilot plant trials, is used, the total capacity of the digesting plant can be increased up to 27000 t/y.

For details see Final test report phase 1b

FINAL TEST REPORT

PHASE 1 A

ON

JUTE PULPING

FOR

UNIDO, VIENNA

BY

I V A

IMPCO-VOEST-ALPINE
Pulping Technologies GmbH

February, 1996
revised
August, 1996

This final report for phase 1a replace the first and second interim report and all submitted preliminary reports.

TABLE OF CONTENT:

1. INTRODUCTION

This project was initiated at the request of

I T C Limited TRIBENI TISSUES DIV.

and was carried out under the contract No. 94/028, UNIDO Project DWG./IND. 2/316 between

IMPCO - VOEST-ALPINE Pulping Technologies Gmbh, Linz, AUSTRIA

and

UNIDO, Vienna, AUSTRIA

In that agreement the objectives of the work were stated to be the determination of:

1. Conditions necessary to produce pulp from jute with the following processes:
   1. Kraft Pulping (Sulphate)
   2. Kraft AQ Pulping
   3. Soda Pulping
   4. Soda AQ Pulping
   5. Alkaline Sulphite Pulping
   6. Alkaline Sulphite AQ Pulping

   to reach a Kappa of 13+- 2 with Indication of yield results.
2. Selecting the optimum conditions of each process and repeating the cook,
3. Physical properties of the pulp produced under the optimum condition.
4. Bleachability of pulp produced under the optimum condition.
5. Pilot plant test at CPPRI with the selected final pulping process executed by CPPRI
6. Bleaching sequences using 2 chlorine-,2 ECF- and 2 TCF-sequences
7. Physical properties of bleached pulp

2. RAW MATERIAL

The raw material for this project was shipped to IVA from the I T C Limited TRIBENI TISSUES DIV, Calcutta, INDIA.

Fibre analysis measured at CPPRI laboratory

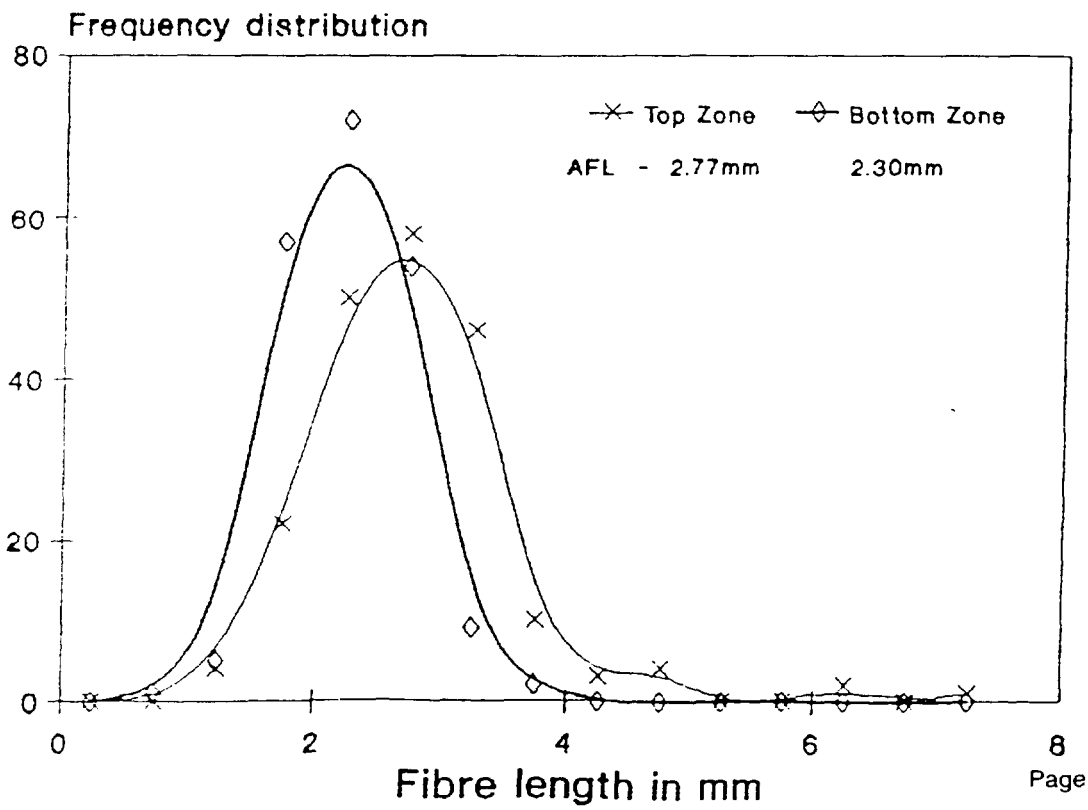
Proximate analysis of jute bast fibre

Se.No.	PROPERTY	UNIT	BAST FIBRE		
			LOWER	TOP	WHOLE
1.	Moisture	%	7.7	6.8	9,1
2.	Ash	%	1.7	0.6	0.3
3.	Water sol	%	0.5	0.5	0.6
4.	Alkali sol	%	15.5	10.7	14.5
5.	Lignin	%	13.8	-	11.8
6.	Holocellulose	%	88.0	90.2	90.0

Dimensions of jute bast fibre

Se.No.	PROPERTY		UNIT	BAST FIBRE		
				whole	top zone	bottom zone
1.	Fibre	length	mm			
		average			2.77	2.33
		maximum			7.44	3.59
		minimum			1.02	1.18
2.	Fibre	width	µm			
		average		11.9		
		maximum		20.0		
		minimum		3.9		
3.	Fibre	lumen	µm			
		average		4.9		
		maximum		11.2		
		minimum		1.0		
4.	Wall	thickness	µm			
		average		3.6		

Length distribution of jute bast fibre



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3. RAW MATERIAL PREPARATION

Bench scale pulping tests at Pulp & Paper Institute in Ljubliana, Slovenia:

The original size of the delivered jute cuts was approx. 250 mm.

We have tested in the pre test phase different size of jute material and we succeed with the original size of approx. 250 mm. Further pre-tests with produced pulp in different beating equipment has been done. The result was that Sprout Waldron Refiner is useful for beating jute pulp with Kappa < 30.

Bench scale pulping tests at CPPRI in Saharanpur, India:

The delivered jute was cute to approx. 75 mm size with the same quality as supplied to IVA.

Pilot plant trials at CPPRI in Saharanpur, India:

The first delivered jute was cute to approx. 75 mm size with the same quality as supplied to IVA.

The second delivered jute was from the same quality and size as supplied to IVA.

4. TESTING METHODS:

The following main testing methods have been used:

- Total active and effective alkali in white liquor	SCAN N 2 : 88
- Kappa number	ISO 302-1981 (E)
- Limiting viscosity number	ISO 5351/1-1981(E)
- Beating of pulp in PFI-mill	ISO 5264/2-1979
- Sheet forming (Rapid Köthen)	ISO 5269/2-1980
- Physical properties of sheets	ISO 5270-1979
- Fibre fractionation (Bauer McNett)	SCAN M6 :69
- Average fibre length and length distribution, Coarseness (Kajaani FS-200)	TAPPI T 271 PM-91
- Brightness	ISO 3688-1977 (5)
-Brightness reversion	ISO 5630/1
-Dirt in pulp	ISO 5350/2-1989 TAPPI 213
- COD (chemical oxygen demand)	DIN 38 409, Teil 41
- BOD (biochemical oxygen demand)	DIN 38 409, Teil 51
- AOX (Determination of adsorbable organic halogens)	DIN 38 409, Teil 14
- Analysis of black liquors	TAPPI T 625 CM-85
- Viscosity of black liquor	TAPPI T 666

5. PULPING EQUIPMENT:

Used at Pulp & Paper Institute in Ljubliana:

Digester: 10 l rotating Digester with electric heating.

Refiner: Sprout Waldron Disc Refiner:

Diam. of plates:	12"
Type of plates:	C-29-76
Space between plates:	0,14"
Speed of refiners:	1500 rpm

Washing: Screen Mesh 16

Screening: WFVERK membrane screen
with screenplate`s opening: 0,15 mm

6. BENCH SCALE PULPING TESTS:

The following laboratory programme was carried out at IVA´ subcontractor Pulp & Paper Institute in Ljubliana, Slovenia to determinate the optimum pulping condition for jute bast fibre supplied by ITC Limited, TRIBENI TISSUE DIV, Calcutta, out of the selected processes.
Target for all tests was to reach a kappa number of 13+-2.
Cooking condition as well as Kappa number, yield, reject amount are presented for every cook.

6.1. Kraft Pulping (Sulphate) and Kraft AQ Pulping

In total 18 laboratory trails were carried out in a 10 l rotary digester with electric heating according to the Kraft process and Kraft AQ process with following parameter:

AA Charge as Na_2O	%	10	12	14
Heating up time	min	90		
Cooking time	min	60	120	240
Temperature	°C	150	160	165
AQ Charge	%	0,05		

After cooking and refining the pulp was washed over a Screen Mesh 16 and screened over a WFVERK membrane screen with screenplate`s opening: 0,15 mm.

The Kraft pulping tests with 12% AA and 160°C with and without AQ were repeated to verify the cooking results.

Details of cooks see table 1 to table 6 as well as figure 1 to figure 4.

Summary of the laboratory trials:

All tests shows that the required AA-charge is about 12 % (as Na_2O) to get a Kappa about 13. In case of Kraft-AQ process the pulp yield was approx. 1% point higher than without AQ.
As high temperature would influence the mechanical properties of pulp and the low temperature would need a long cooking time the following parameter for the final pulping test was selected:

AA-charge	12 % as Na_2O
Sulfidity	20 %
Cooking temperature	160°C
Cooking time	2 hours
AQ-charge	0,05 % in case of Kraft-AQ Process

6.2. Soda and Soda AQ Pulping

In total 18 laboratory trails were carried out in a 10 l rotary digester with electric heating according to the Soda process and Soda AQ process with following parameter:

AA Charge as Na_2O	%	12	14	16
Heating up time	min	90		
Cooking time	min	60	120	240
Temperature	°C	150	160	165
AQ Charge	%	0,05		

After cooking and refining the pulp was washed over a Screen Mesh 16 and screened over a WFVERK membrane screen with screenplate`s opening: 0,15 mm.

Details of cooks see table 7 to table 12 as well as figure 5 to figure 8.

Summary of the laboratory trials:

All tests shows that the required AA-charge is about 14 % (as Na_2O)to get a Kappa about 13. In case of Soda-AQ process the pulp yield was approx. 1% point higher than without AQ and the AA-charge can be reduced by min. 0,5% point when using a cooking temperature of 160°C. As high temperature would influence the mechanical properties of pulp and the low temperature would need a long cooking time the following parameter for the final pulping test was selected:

	SODA	SODA-AQ
AA-charge	14 %	13,5 as Na_2O
Cooking temperature	160°C	
Cooking time	2 hours	
AQ-charge	-	0,05 %

6.3. Alkaline sulphite and Alkaline sulphite-AQ pulping

In total 8 laboratory trails were carried out in a 10 l rotary digester with electric heating according to the alkaline sulphite and alkaline sulphite-AQ process with following parameter:

NaOH Charge	%	2	2,5	4	8
SO_2 Equivalent	%	8	10	16	24
Na_2SO_3 Charge	%	15,75	19,69	31,50	47,25
Heating up time	min	90			
Cooking time	min	240			
Temperature	°C	165			
AQ Charge	%	0,05			

After cooking and refining the pulp was washed over a Screen Mesh 16 and screened over a WFVERK membrane screen with screenplate`s opening: 0,15 mm.

Details of cooks see table 13 to table 14 as well as figure 9 to figure 10.

Summary of the laboratory trials:

The tests shows that alkaline sulphite pulping process with an NaOH /SO_2 ratio of 1:3 - 1:4 , a relative high chemical charge, a high temperature of 165° and a long cooking time of 4 hours could not achieve the desired kappa number. the lowest kappa number was 51,3 at an Na_2SO_3 charge of 47,25 %. With an addition 0f 0,05 % AQ the kappa number could be reduced to approx. 19.
As the target kappa could not be reached with alkaline sulphite process and the results of AQ addition brought kappa down to approx. 19, it was decided that only Alkaline sulphite final cooks with AQ-addition will be used for the final pulping test with the following parameter:

Na2SO3-charge	47,25 %	(24 % SO_2)
Cooking temperature	165°C	
Cooking time	4 hours	
AQ-charge	0,05 %	

6.4. Final pulping tests for determination of physical properties and bleachability tests.

In total 10 laboratory trails were carried out in a 10 l rotary digester with electric heating according to following parameter:

Process	AA charge as Na_2O (Na_2SO_3) %	Heating up time min	Digesting time min	Temp. °C
Kraft	12	90	120	160
Kraft AQ	12	90	120	160
Soda	14	90	120	160
Soda AQ	13,5	90	120	160
Alkaline sulphite	no final pulping tests			
Alkaline sulphite AQ	47,25 (= 24 % as SO_2)	90	240	165

Sulfidity for Kraft and Kraft-AQ pulping process = 20 %

After cooking and refining the pulp was washed over a Screen Mesh 16 and screened over a WFVERK membrane screen with screenplate`s opening: 0,15 mm.

Details of cooks see table 15a to table 19a

Physical properties of unbleached jute pulp see table 15b to table 19b

Fibre analysis see distribution analysis of unbleached jute pulp

Physical properties of each unbleached jute pulp see figure 11 to figure 15

Fibre length unbleached jute pulp see figure 16

Coarseness unbleached jute pulp see figure 17

Slenderness factor unbleached jute pulp see figure 18

Zero span tensile unbleached jute pulp see figure 19

Physical properties unbleached jute pulp at 50 SR see figure 20 to figure 27

Physical properties unbleached jute pulp at 30 SR see figure 28 to figure 33

Viscosity of unbleached jute pulp see figure 34

6.5. Summary of the laboratory trials:

All tests verify the selected pulping conditions.

For the selection of final process to be tested in the pilot plant of CPPRI the following matrix was prepared:

Process	Kraft	Kraft -AQ	Soda	Soda -AQ	Alkaline -AQ
Kappa number	3	2	4	1	5
Chemical consumption	2	1	4	3	5
Energy consumption	2	1	4	3	5
Chemical recovery	2	1	4	3	5
Yield unbleached	3	2	5	4	1
Viscosity unbleached	3	2	3	4	1
Bleaching chemical consumption *	4	2	3	1	5
Dirt content bleached *	3	2	1	5	4
Breaking length at 30 SR	2	1	4	5	3
Fibre length	2	2	3	1	2
Fibre strength	3	2	2	4	1
Slenderness factor	3	2	4	1	5
Total	33	21	44	39	47

*) From the bleachability test results

Note:	1	=	Excellent
	2	=	Very good
	3	=	Good
	4	=	Sufficient
	5	=	Insufficient

From this matrix the pulping processes can be ranged as follow:
1. Kraft-AQ
2. Kraft
3. Soda-AQ
4. Soda
5. Alkaline sulphite

7. BLEACHABILITY TESTS

The following laboratory programme was carried out at IVA´ subcontractor Pulp & Paper Institute in Ljubliana, Slovenia to determinate the bleachability of the pulp produced under the prescribed conditions to support the selection of the final pulping process to be used in the pilot plant test at CPPRI in Saharanpur, India.
The bleachability tests were carried out with the sequence **C - E - H**.

For the Kraft and Kraft-AQ we used the following Parameter:
Chlorinating factor for C-Stage = approx. 0,25.
As this factor was high it was reduced to 0,2 for all other tests

Bleaching parameter:

		KRAFT	KRAFT -AQ	SODA	SODA -AQ	ALK.SULF .-AQ
C-Stage:						
Chlorine factor	-	0,25	0,25	0,2	0,2	0,2
Consistency	%	3,0	3,0	3,0	3,0	3,0
Retention time	min	30	30	30	30	30
Temperature	°C	20	20	20	20	20
E-Stage:						
NaOH charge	%	1,5	1,2	1,2	1,2	1,2
Consistency	%	10,0	10,0	10,0	10,0	10,0
Retention time	min	90	90	90	90	90
Temperature	°C	60	60	60	60	60
H-Stage:						
A.Chlor. charge	%-	1,5	1,5	1,5	1,5	1,5
Consistency	%	10,0	10,0	10,0	10,0	10,0
Retention time	min	150	150	150	150	150
Temperature	°C	40	40	40	40	40

Details of bleachability tests see table 20a to table 24a

Physical properties bleached jute pulp see table 20b to table 24b

Fibre analysis see Fibre distribution analysis of bleached jute pulp

Total active chlorine consumption see figure 36

Bleached jute pulp total yield see figure 37

Physical properties of each bleached pulp see figure 38 to figure 42

Fibre length of bleached jute pulp see figure 43

Coarseness of bleached jute pulp see figure 44

Slenderness factor of bleached jute pulp see figure 45

Zero span tensile of bleached jute pulp see figure 46

Physical properties of bleached jute pulp at 50 SR see figure 47 to figure 58

Physical properties of bleached jute pulp at 30 SR see figure 59 to figure 70

Viscosity of bleached jute pulp see figure 71

8. BENCH SCALE AND PILOT PLANT TRAILS AT CPPRI IN SAHARANPOUR

The following laboratory programs were carried out at CPPRI laboratory and pilot plant to check the results obtained at IVA´ subcontractor Pulp & Paper Institute in Ljubliana, Slovenia for jute bast fibre supplied by ITC Limited, TRIBENI TISSUE DIV, Calcutta.
Target for all tests was to reach a kappa number of 13+-2.
Cooking condition as well as Kappa number are presented for every cook.

8.1. Kraft Pulping (Sulphate) and Kraft AQ Pulping

The **laboratory trails** were carried out in a 2.5 l rotary digester with electric heating according to the Kraft process and Kraft AQ process with following parameter:

AA Charge as Na_2O	%	12	12
Sulfidity	%	20	20
Heating up time	min	90	90
Cooking time	min	120	120
Temperature	°C	160	160
AQ Charge	%	0,00	0,05

Details of cooks see table 25 to table 26

The **pilot plant trails** were carried out in a cylindrical rotary digester (Size = 11 m^3)with direct steam heating according to the Kraft process and Kraft AQ process with following parameter:

AA Charge as Na_2O	%	12	11.5	12	12	11.5
Sulfidity	%	20	20	20	20	20
Heating up time	min	90	90	90	90	90
Cooking time	min	120	120	180	240	120
Temperature	°C	160	160	160	150	160
AQ Charge	%	0,00	0,00	0,05	0,05	0,05

After cooking the pulp was blown in an blow tank and washed on an belt washer.

Details of cooks see table 27 to table 32

Summary of the laboratory and pilot plant trials:

All the tests at the laboratory and pilot plant of CPPRI as well as tests at Tribeni Tissue Laboratory confirm the cooking results of IVA.

AA-charge	12 % as Na_2O
Sulfidity	20 %
Cooking temperature	160°C
Cooking time	2 hours
AQ-charge	0,05 % in case of Kraft-AQ Process

See figures 81 to 92

Pulp produced during the Pilot plant tests at CPPRI was blown in a blow tank at different pressure without any problem.

Additional trial was carried out at SHAMLI Paper Mill (located near to Saharanpur) in a spherical digester with soda-AQ process to confirm the blowability of jute pulp not only from a cylindrical digester with conical bottom but also out of a spherical digester.

The result of this trial is:

Jute pulp at the processed Kappa No. can be also blown from a spherical digester ! ! !

9. BENCH SCALE BLEACHING TRAILS

The following laboratory programme was carried out at IVA´ subcontractors Pulp & Paper Institute in Ljubliana, Slovenia and ÖHFI in Vienna to determinate the bleachability of the pulp produced in the pilot plant at CPPRI under the prescribed conditions to support the selection of the final bleaching process to be used at Tribeni mill, India.
The bleaching tests were carried out with the sequences

C - E - H

C - Ep - H

O -C - EO - H

D - E - D

O -D - EO - D

O -A - EOP - P / O -Q - EOP - P

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

During the execution of the bleaching tests it was founded that IVA-Laboratories used for the brightness measurement the absolute value and CPPRI and Tribeni mill the relative value so that all results of IVA have to be increased by approx. 2 % points to get comparable results to CPPRI and Tribeni mill.

A = Acidification stage

C = Chlorination stage

D = Chlorine dioxide stage

E = Extraction stage

EO = Extraction stage with addition of oxygen

EOP = Extraction stage with addition of oxygen and peroxide

EP = Extraction stage with addition of peroxide

H = Hypo stage

O = Oxygen delignification

P = Peroxide stage

Q = Chelation stage

Z = Ozone stage

9.1 C - E - H bleaching:

The target brightness for this sequence was 84 %.

In total 7 laboratory bleaching trials were carried out.

The final results of brightness measurement was :

82,8 % ISO	absolute
84,8 %	relative

Details of bleaching parameter and results see table 40

9.2 C - EP - H bleaching:

The target brightness for this sequence was 86 %.

In total 5 laboratory bleaching trials were carried out.

The final results of brightness measurement was :

85,0 % ISO	absolute
87,2 %	relative

Details of bleaching parameter and results see table 41

9.3 O - C - EO - H bleaching:

The target brightness for this sequence was 86 %.

In total 4 laboratory bleaching trials were carried out.

The final results of brightness measurement was :

83,0 % ISO	absolute
85,0 %	relative

Details of bleaching parameter and results see table 42

9.4 D - E - D bleaching:

The target brightness for this sequence was 87,5 %.

In total 7 laboratory bleaching trials were carried out.

The final results of brightness measurement was :

85,8 % ISO	absolute
87,0 %	relative

Details of bleaching parameter and results see table 43

9.5 O - D - EO - D bleaching:

The target brightness for this sequence was 88 %.

In total 3 laboratory bleaching trials were carried out.

The final results of brightness measurement was :

82,4 % ISO	absolute
84,4 %	relative

Details of bleaching parameter and results see table 44

9.6 O - A - EOP - P / O - Q - EOP - P bleaching:

The target brightness for this sequence was 84-85 %.

In total 3 laboratory bleaching trials were carried out.

The final results of brightness measurement was :

82,7 % ISO	absolute
84,7 %	relative

Details of bleaching parameter and results see table 45

9.7 O - A - Z - P / O - Q - Z - P bleaching:

The target brightness for this sequence was 84-85 %.

In total 3 laboratory bleaching trials were carried out.

The final results of brightness measurement was :

84,8-87,3 % ISO	absolute
86,8-89,3 %	relative

Details of bleaching parameter and results see table 46

9.8 Quality of unbleached pulp:

During the bleaching trials it was found that a part of the pulp send by air freight and submitted through IVA to the Pulp and Paper Institute in Ljubliana, was detoriated and had to be separated from the good pulp to avoid further degradation.
This was one of the reasons why this institute failed to achieve the target brightness in some of there tests.

Table 33 and 34 shows the physical properties of both kind of pulp.

9.9 Summary of bleaching trials:

Generally the bleaching results were in an acceptable ranges.

With the simplest bleaching sequence C E H a brightness of 84,8 % could be achieved.
When adding peroxide in the extraction stage the final brightness increased to 87,2 with a reduced total chlorine consumption.
Adding an oxygen delignification prior to the chlorination stage improve the total chlorine consumption.

Introducing chlorine dioxide instead of chlorine and hypo results in a brightness of 87 %. Adding an oxygen delignification prior to the first chlorine dioxide stage improve the total chlorine consumption.

In case of total chlorine free bleaching with Oxygen and peroxide the final brightness was 84,7 %. Introducing ozone in an total chlorine free bleaching sequence increased the final brightness up to 89,3 %.

See table 47 and figures 101 to 129 and the following table !

10. TABLES

10.1 Bench scale pulping tests

TABLE 1

Jute pulping **Kraft pulping at 165°C**

Laboratory: **Pulp and Paper Institute**
City: **Ljubliana**
Country: **Slovenia**
Conducted by: **IVA, Linz AUSTRIA , Dipl.Ing. Mohamed NAGA**
Date: **January-March 1995**
Client: **UNIDO, Vienna for Tribeni Mill**

	Unit			
Raw material		Jute	Jute	Jute
Quality of Fiber				
Size of fiber	mm	250	250	250
Pulping data				
Pulping Process		Kraft	Kraft	Kraft
Cook No.		K01	K02	K03
Type of digester		Rotary, elect. heated	Rotary, elect. heated	Rotary, elect. heated
Size	l	10	10	10
Hydromodul	1:??	3,00	3,00	3,00
Raw material charge	g	341	341	341
	gBD	300	300	300
Dry content	%	88,00	88,00	88,00
NaOH Charge	%	14,60	12,51	10,43
Na2S Charge	%	3,38	2,90	2,42
Sulfidity	%	19,20	19,20	19,20
SO2 Charge	%	-	-	-
Na2SO3 Charge	%	-	-	-
Active Alkali charge as Na2O	%	14,00	12,00	10,00
Effective Alkali charge as Na2O	%	12,66	10,85	9,04
AQ charge	%	-	-	-
Heating up time	min	90	90	90
Cooking time	min	60	60	60
Cooking temp.	°C	165	165	165
H Factor	-	702,3	702,3	702,3
Yield unscreened	%	59,50	58,40	61,20
Screen reject	%	negl.	negl.	negl.
Yield screened	%	59,50	58,40	61,20
Kappa No.		11,20	12,50	27,20

TABLE 2

Jute pulping **Kraft pulping at 160°C**

Laboratory: **Pulp and Paper Institute**
City: **Ljubliana**
Country: **Slovenia**
Conducted by: **IVA, Linz AUSTRIA , Dipl.Ing. Mohamed NAGA**
Date: **January-March 1995**
Client: **UNIDO, Vienna for Tribeni Mill**

	Unit							
Raw material		Jute	Jute	Jute	Jute	Jute		Jute
Quality of Fiber								
Size of fiber	mm	250	250	250	250	250		250
Pulping data								
Pulping Process		Kraft	Kraft	Kraft	Kraft	Kraft		Kraft
Cook No.		K04	K05	K 05A	K 05B	K 05C	K05-K05c	K06
Type of digester		Rotary, elect. heated	Rotary, elect. heated	Rotary, elect. heated	Rotary, elect. heated	Rotary, elect. heated		Rotary, elect. heated
Size	l	10	10	10	10	10		10
Hydromodul	1:??	3,00	3,00	3,00	3,00	3,00		3,00
Raw material charge	g	341	341	341	455	455		341
	gBD	300	300	300	400	400		300
Dry content	%	88,00	88,00	88,00	88,00	88,00		88,00
NaOH Charge	%	14,60	12,51	12,51	12,51	12,51		10,43
Na2S Charge	%	3,38	2,90	2,90	2,90	2,90		2,42
Sulfidity	%	19,20	19,20	19,20	19,20	19,20		19,20
SO2 Charge	%	-	-	-	-	-		-
Na2SO3 Charge	%	-	-	-	-	-		-
Active Alkali charge as Na2O	%	14,00	12,00	12,00	12,00	12,00		10,00
Effective Alkali charge as Na2O	%	12,66	10,85	10,85	10,85	10,85		9,04
AQ charge	%	-	-	-	-	-		-
Heating up time	min	90	90	90	90	90		90
Cooking time	min	120	120	120	120	120		120
Cooking temp.	°C	160	160	160	160	160		160
H Factor	-	859,6	859,6	859,6	859,6	859,6		859,6
Yield unscreened	%	56,40	61,00	60,20	57,80	61,00	60,73	60,60
Screen reject	%	negl.	negl.	negl.	negl.	negl.		negl.
Yield screened	%	56,40	61,00	60,20	57,80	61,00	60,73	60,60
Kappa No.		10,40	12,40	14,10	12,00	12,40	12,27	21,90

TABLE 3

Jute pulping **Kraft pulping at 150°C**

Laboratory: **Pulp and Paper Institute**
City: **Ljubliana**
Country: **Slovenia**
Conducted by: **IVA, Linz AUSTRIA , Dipl.Ing. Mohamed NAGA**
Date: **January-March 1995**
Client: **UNIDO, Vienna for Tribeni Mill**

	Unit			
Raw material		Jute	Jute	Jute
Quality of Fiber				
Size of fiber	mm	250	250	250
Pulping data				
Pulping Process		Kraft	Kraft	Kraft
Cook No.		K07	K08	K09
Type of digester		Rotary, elect. heated	Rotary, elect. heated	Rotary, elect. heated
Size	l	10	10	10
Hydromodul	1:??	3,00	3,00	3,00
Raw material charge	g	341	341	341
	gBD	300	300	300
Dry content	%	88,00	88,00	88,00
NaOH Charge	%	14,60	12,51	10,43
Na2S Charge	%	3,38	2,90	2,42
Sulfidity	%	19,20	19,20	19,20
SO2 Charge	%	-	-	-
Na2SO3 Charge	%	-	-	-
Active Alkali charge as Na2O	%	14,00	12,00	10,00
Effective Alkali charge as Na2O	%	12,66	10,85	9,04
AQ charge	%	-	-	-
Heating up time	min	90	90	90
Cooking time	min	240	240	240
Cooking temp.	°C	150	150	150
H Factor	-	688,2	688,2	688,2
Yield unscreened	%	59,30	59,70	62,30
Screen reject	%	negl.	negl.	negl.
Yield screened	%	59,30	59,70	62,30
Kappa No.		11,20	13,50	27,30

TABLE 4

Jute pulping **Kraft AQ pulping at 165°C**

Laboratory: **Pulp and Paper Institute**
City: **Ljubliana**
Country: **Slovenia**
Conducted by: **IVA, Linz AUSTRIA , Dipl.Ing. Mohamed NAGA**
Date: **January-March 1995**
Client: **UNIDO, Vienna for Tribeni Mill**

	Unit			
Raw material		Jute	Jute	Jute
Quality of Fiber				
Size of fiber	mm	250	250	250
Pulping data				
Pulping Process		Kraft AQ	Kraft AQ	Kraft AQ
Cook No.		KAQ01	KAQ02	KAQ03
Type of digester		Rotary, elect. heated	Rotary, elect. heated	Rotary, elect. heated
Size	l	10	10	10
Hydromodul	1:??	3,00	3,00	3,00
Raw material charge	g	341	341	341
	gBD	300	300	300
Dry content	%	88,00	88,00	88,00
NaOH Charge	%	14,60	12,51	10,43
Na2S Charge	%	3,38	2,90	2,42
Sulfidity	%	19,20	19,20	19,20
SO2 Charge	%	-	-	-
Na2SO3 Charge	%	-	-	-
Active Alkali charge as Na2O	%	14,00	12,00	10,00
Effective Alkali charge as Na2O	%	12,66	10,85	9,04
AQ charge	%	0,05	0,05	0,05
Heating up time	min	90	90	90
Cooking time	min	60	60	60
Cooking temp.	°C	165	165	165
H Factor	-	702,3	702,3	702,3
Yield unscreened	%	59,70	61,80	61,90
Screen reject	%	negl.	negl.	negl.
Yield screened	%	59,70	61,80	61,90
Kappa No.		10,60	11,80	16,00

TABLE 5

Jute pulping **Kraft AQ pulping at 160°C**

Laboratory: **Pulp and Paper Institute**
City: **Ljubliana**
Country: **Slovenia**
Conducted by: **IVA, Linz AUSTRIA , Dipl.Ing. Mohamed NAGA**
Date: **January-March 1995**
Client: **UNIDO, Vienna for Tribeni Mill**

	Unit							
Raw material		Jute	Jute	Jute	Jute	Jute		Jute
Quality of Fiber								
Size of fiber	mm	250	250	250	250	250		250
Pulping data								
Pulping Process		Kraft AQ	Kraft AQ	Kraft AQ	Kraft AQ	Kraft AQ		Kraft AQ
Cook No.		KAQ04	KAQ05	KAQ05 A	KAQ05 B	KAQ05 C	KAQ5-KAQ5C	KAQ06
Type of digester		Rotary, elect. heated	Rotary, elect. heated	Rotary, elect. heated	Rotary, elect. heated	Rotary, elect. heated		Rotary, elect. heated
Size	l	10	10	10	10	10		10
Hydromodul	1:??	3,00	3,00	3,00	3,00	3,00		3,00
Raw material charge	g	341	341	341	455	455		341
	gBD	300	300	300	400	400		300
Dry content	%	88,00	88,00	88,00	88,00	88,00		88,00
NaOH Charge	%	14,60	12,51	12,51	12,51	12,51		10,43
Na2S Charge	%	3,38	2,90	2,90	2,90	2,90		2,42
Sulfidity	%	19,20	19,20	19,20	19,20	19,20		19,20
SO2 Charge	%	-	-	-	-	-		-
Na2SO3 Charge	%	-	-	-	-	-		-
Active Alkali charge as Na2O	%	14,00	12,00	12,00	12,00	12,00		10,00
Effective Alkali charge as Na2O	%	12,66	10,85	10,85	10,85	10,85		9,04
AQ charge	%	0,05	0,05	0,05	0,05	0,05		0,05
Heating up time	min	90	90	90	90	90		90
Cooking time	min	120	120	120	120	120		120
Cooking temp.	°C	160	160	160	160	160		160
H Factor	-	859,6	859,6	859,6	859,6	859,6		859,6
Yield unscreened	%	57,40	62,00	61,00	61,60	62,00	61,65	61,90
Screen reject	%	negl.	negl.	negl.	negl.	negl.		negl.
Yield screened	%	57,40	62,00	61,00	61,60	62,00	61,65	61,90
Kappa No.		9,70	12,20	12,30	11,50	12,00	12,00	14,40

TABLE 6

Jute pulping **Kraft AQ pulping at 150°C**

Laboratory: **Pulp and Paper Institute**
City: **Ljubliana**
Country: **Slovenia**
Conducted by: **IVA, Linz AUSTRIA , Dipl.Ing. Mohamed NAGA**
Date: **January-March 1995**
Client: **UNIDO, Vienna for Tribeni Mill**

	Unit			
Raw material		Jute	Jute	Jute
Quality of Fiber				
Size of fiber	mm	250	250	250
Pulping data				
Pulping Process		Kraft AQ	Kraft AQ	Kraft AQ
Cook No.		KAQ07	KAQ08	KAQ09
Type of digester		Rotary, elect. heated	Rotary, elect. heated	Rotary, elect. heated
Size	l	10	10	10
Hydromodul	1:??	3,00	3,00	3,00
Raw material charge	g	341	341	341
	gBD	300	300	300
Dry content	%	88,00	88,00	88,00
NaOH Charge	%	14,60	12,51	10,43
Na2S Charge	%	3,38	2,90	2,42
Sulfidity	%	19,20	19,20	19,20
SO2 Charge	%	-	-	-
Na2SO3 Charge	%	-	-	-
Active Alkali charge as Na2O	%	14,00	12,00	10,00
Effective Alkali charge as Na2O	%	12,66	10,85	9,04
AQ charge	%	0,05	0,05	0,05
Heating up time	min	90	90	90
Cooking time	min	240	240	240
Cooking temp.	°C	150	150	150
H Factor	-	688,2	688,2	688,2
Yield unscreened	%	60,60	62,30	61,90
Screen reject	%	negl.	negl.	negl.
Yield screened	%	60,60	62,30	61,90
Kappa No.		8,70	12,40	18,30

TABLE 7

Jute pulping **Soda pulping at 165°C**

Laboratory: **Pulp and Paper Institute**
City: **Ljubliana**
Country: **Slovenia**
Conducted by: **IVA, Linz AUSTRIA , Dipl.Ing. Mohamed NAGA**
Date: **January-March 1995**
Client: **UNIDO, Vienna for Tribeni Mill**

	Unit			
Raw material		Jute	Jute	Jute
Quality of Fiber				
Size of fiber	mm	250	250	250
Pulping data				
Pulping Process		Soda	Soda	Soda
Cook No.		S01	S02	S03
Type of digester		Rotary, elect. heated	Rotary, elect. heated	Rotary, elect. heated
Size	l	10	10	10
Hydromodul	1:??	3,00	3,00	3,00
Raw material charge	g	341	341	341
	gBD	300	300	300
Dry content	%	88,00	88,00	88,00
NaOH Charge	%	20,65	18,06	15,48
Na2S Charge	%	0,00	0,00	0,00
Sulfidity	%	0,00	0,00	0,00
SO2 Charge	%	-	-	-
Na2SO3 Charge	%	-	-	-
Active Alkali charge as Na2O	%	16,00	14,00	12,00
Effective Alkali charge as Na2O	%	16,00	14,00	12,00
AQ charge	%	-	-	-
Heating up time	min	90	90	90
Cooking time	min	60	60	60
Cooking temp.	°C	165	165	165
H Factor	-	702,3	702,3	702,3
Yield unscreened	%	56,90	56,10	57,80
Screen reject	%	negl.	negl.	negl.
Yield screened	%	56,90	56,10	57,80
Kappa No.		14,80	16,50	37,70

TABLE 8

Jute pulping **Soda pulping at 160°C**

Laboratory: **Pulp and Paper Institute**
City: **Ljubliana**
Country: **Slovenia**
Conducted by: **IVA, Linz AUSTRIA , Dipl.Ing. Mohamed NAGA**
Date: **January-March 1995**
Client: **UNIDO, Vienna for Tribeni Mill**

	Unit						
Raw material		Jute	Jute	Jute	Jute		Jute
Quality of Fiber							
Size of fiber	mm	250	250	250	250		250
Pulping data							
Pulping Process		Soda	Soda	Soda	Soda		Soda
Cook No.		S04	S05	S 05A	S 05B		S06
Type of digester		Rotary, elect. heated	Rotary, elect. heated	Rotary, elect. heated	Rotary, elect. heated		Rotary, elect. heated
Size	l	10	10	10	10		10
Hydromodul	1:??	3,00	3,00	3,00	3,00		3,00
Raw material charge	g	341	341	454,55	454,55		341
	gBD	300	300	400,00	400,00		300
Dry content	%	88,00	88,00	88,00	88,00		88,00
NaOH Charge	%	20,65	18,06	18,06	18,06		15,48
Na2S Charge	%	0,00	0,00	0,00	0,00		0,00
Sulfidity	%	0,00	0,00	0,00	0,00		0,00
SO2 Charge	%	-	-	-	-		-
Na2SO3 Charge	%	-	-	-	-		-
Active Alkali charge as Na2O	%	16,00	14,00	14,00	14,00		12,00
Effective Alkali charge as Na2O	%	16,00	14,00	14,00	14,00		12,00
AQ charge	%	-	-	-	-		-
Heating up time	min	90	90	90	90		90
Cooking time	min	120	120	120	120		120
Cooking temp.	°C	160	160	160	160		160
H Factor	-	859,6	859,6	859,6	859,6		859,6
Yield unscreened	%	58,70	58,30	57,80	58,30	58,13	61,70
Screen reject	%	negl.	negl.	negl.	negl.		negl.
Yield screened	%	58,70	58,30	57,80	58,30	58,13	61,70
Kappa No.		14,10	12,90	17,60	12,90	14,47	33,20

TABLE 9

Jute pulping **Soda pulping at 150°C**

Laboratory: **Pulp and Paper Institute**
City: **Ljubliana**
Country: **Slovenia**
Conducted by: **IVA, Linz AUSTRIA , Dipl.Ing. Mohamed NAGA**
Date: **January-March 1995**
Client: **UNIDO, Vienna for Tribeni Mill**

	Unit			
Raw material		Jute	Jute	Jute
Quality of Fiber				
Size of fiber	mm	250	250	250
Pulping data				
Pulping Process		Soda	Soda	Soda
Cook No.		S07	S08	S09
Type of digester		Rotary, elect. heated	Rotary, elect. heated	Rotary, elect. heated
Size	l	10	10	10
Hydromodul	1:??	3,00	3,00	3,00
Raw material charge	g	340,91	340,91	340,91
	gBD	300,00	300,00	300,00
Dry content	%	88,00	88,00	88,00
NaOH Charge	%	20,65	18,06	15,48
Na2S Charge	%	0,00	0,00	0,00
Sulfidity	%	0,00	0,00	0,00
SO2 Charge	%	-	-	-
Na2SO3 Charge	%	-	-	-
Active Alkali charge as Na2O	%	16,00	14,00	12,00
Effective Alkali charge as Na2O	%	16,00	14,00	12,00
AQ charge	%	-	-	-
Heating up time	min	90	90	90
Cooking time	min	240	240	240
Cooking temp.	°C	150	150	150
H Factor	-	688,2	688,2	688,2
Yield unscreened	%	58,10	57,20	57,80
Screen reject	%	negl.	negl.	negl.
Yield screened	%	58,10	57,20	57,80
Kappa No.		17,20	20,30	42,80

TABLE 10

Jute pulping **Soda AQ pulping at 165°C**

Laboratory: **Pulp and Paper Institute**
City: **Ljubliana**
Country: **Slovenia**
Conducted by: **IVA, Linz AUSTRIA , Dipl.Ing. Mohamed NAGA**
Date: **January-March 1995**
Client: **UNIDO, Vienna for Tribeni Mill**

	Unit			
Raw material		Jute	Jute	Jute
Quality of Fiber				
Size of fiber	mm	250	250	250
Pulping data				
Pulping Process		Soda AQ	Soda AQ	Soda AQ
Cook No.		SAQ01	SAQ02	SAQ03
Type of digester		Rotary, elect. heated	Rotary, elect. heated	Rotary, elect. heated
Size	l	10	10	10
Hydromodul	1:??	3,00	3,00	3,00
Raw material charge	g	340,91	340,91	340,91
	gBD	300,00	300,00	300,00
Dry content	%	88,00	88,00	88,00
NaOH Charge	%	20,65	18,06	15,48
Na2S Charge	%	0,00	0,00	0,00
Sulfidity	%	0,00	0,00	0,00
SO2 Charge	%	-	-	-
Na2SO3 Charge	%	-	-	-
Active Alkali charge as Na2O	%	16,00	14,00	12,00
Effective Alkali charge as Na2O	%	16,00	14,00	12,00
AQ charge	%	0,05	0,05	0,05
Heating up time	min	90	90	90
Cooking time	min	60	60	60
Cooking temp.	°C	165	165	165
H Factor	-	702,3	702,3	702,3
Yield unscreened	%	57,30	56,40	58,00
Screen reject	%	negl.	negl.	negl.
Yield screened	%	57,30	56,40	58,00
Kappa No.		10,30	10,60	28,10

TABLE 11

Jute pulping **Soda AQ pulping at 160°C**

Laboratory: **Pulp and Paper Institute**
City: **Ljubliana**
Country: **Slovenia**
Conducted by: **IVA, Linz AUSTRIA , Dipl.Ing. Mohamed NAGA**
Date: **January-March 1995**
Client: **UNIDO, Vienna for Tribeni Mill**

	Unit						
Raw material		Jute	Jute	Jute	Jute		Jute
Quality of Fiber							
Size of fiber	mm	250	250	250	250		250
Pulping data							
Pulping Process		Soda AQ	Soda AQ	Soda AQ	Soda AQ		Soda AQ
Cook No.		SAQ04	SAQ05	SAQ10	SAQ10 A		SAQ06
Type of digester		Rotary, elect. heated	Rotary, elect. heated	Rotary, elect. heated	Rotary, elect. heated		Rotary, elect. heated
Size	l	10	10	10	10		10
Hydromodul	1:??	3,00	3,00	3,00	3,00		3,00
Raw material charge	g	340,91	340,91	454,55	454,55		340,91
	gBD	300,00	300,00	400,00	400,00		300,00
Dry content	%	88,00	88,00	88,00	88,00		88,00
NaOH Charge	%	20,65	18,06	17,42	17,42		15,48
Na2S Charge	%	0,00	0,00	0,00	0,00		0,00
Sulfidity	%	0,00	0,00	0,00	0,00		0,00
SO2 Charge	%	-	-	-	-		-
Na2SO3 Charge	%	-	-	-	-		-
Active Alkali charge as Na2O	%	16,00	14,00	13,50	13,50		12,00
Effective Alkali charge as Na2O	%	16,00	14,00	13,50	13,50		12,00
AQ charge	%	0,05	0,05	0,05	0,05		0,05
Heating up time	min	90	90	90	90		90
Cooking time	min	120	120	120	120		120
Cooking temp.	°C	160	160	160	160		160
H Factor	-	859,6	859,6	859,6	859,6		859,6
Yield unscreened	%	59,40	58,60	60,10	60,10	60,10	60,90
Screen reject	%	negl.	negl.	negl.	negl.		negl.
Yield screened	%	59,40	58,60	60,10	60,10	60,10	60,90
Kappa No.		8,70	10,20	11,70	10,20	10,95	19,70

TABLE 12

Jute pulping **Soda AQ pulping at 150°C**

Laboratory: **Pulp and Paper Institute**
City: **Ljubliana**
Country: **Slovenia**
Conducted by: **IVA, Linz AUSTRIA , Dipl.Ing. Mohamed NAGA**
Date: **January-March 1995**
Client: **UNIDO, Vienna for Tribeni Mill**

	Unit			
Raw material		Jute	Jute	Jute
Quality of Fiber				
Size of fiber	mm	250	250	250
Pulping data				
Pulping Process		Soda AQ	Soda AQ	Soda AQ
Cook No.		SAQ07	SAQ08	SAQ09
Type of digester		Rotary, elect. heated	Rotary, elect. heated	Rotary, elect. heated
Size	l	10	10	10
Hydromodul	1:??	3,00	3,00	3,00
Raw material charge	g	340,91	340,91	340,91
	gBD	300,00	300,00	300,00
Dry content	%	88,00	88,00	88,00
NaOH Charge	%	20,65	18,06	15,48
Na2S Charge	%	0,00	0,00	0,00
Sulfidity	%	0,00	0,00	0,00
SO2 Charge	%	-	-	-
Na2SO3 Charge	%	-	-	-
Active Alkali charge as Na2O	%	16,00	14,00	12,00
Effective Alkali charge as Na2O	%	16,00	14,00	12,00
AQ charge	%	0,05	0,05	0,05
Heating up time	min	90	90	90
Cooking time	min	240	240	240
Cooking temp.	°C	150	150	150
H Factor	-	688,2	688,2	688,2
Yield unscreened	%	57,70	58,90	58,40
Screen reject	%	negl.	negl.	negl.
Yield screened	%	57,70	58,90	58,40
Kappa No.		9,90	13,20	16,10

TABLE 13

Jute pulping **Alkaline sulphite pulping at 165°C**

Laboratory: **Pulp and Paper Institute**
City: **Ljubliana**
Country: **Slovenia**
Conducted by: **IVA, Linz AUSTRIA , Dipl.Ing. Mohamed NAGA**
Date: **January-March 1995**
Client: **UNIDO, Vienna for Tribeni Mill**

	Unit				
Raw material		Jute	Jute	Jute	Jute
Quality of Fiber					
Size of fiber	mm	250	250	250	250
Pulping data					
Pulping Process		Alkal. Sulphite	Alkal. Sulphite	Alkal. Sulphite	Alkal. Sulphite
Cook No.		AS 01	AS 02	AS 03	AS 04
Type of digester		Rotary, elect. heated	Rotary, elect. heated	Rotary, elect. heated	Rotary, elect. heated
Size	l	10	10	10	10
Hydromodul	1:??	3,00	3,00	3,00	3,00
Raw material charge	g	340,91	340,91	340,91	340,91
	gBD	300,00	300,00	300,00	300,00
Dry content	%	88,00	88,00	88,00	88,00
NaOH Charge	%	2,00	2,50	4,00	8,00
Na2S Charge	%	-	-	-	-
Sulfidity	%	-	-	-	-
SO2 Charge	%	8,00	10,00	16,00	24,00
Na2SO3 Charge	%	15,75	19,69	31,50	47,25
Active Alkali charge as Na2O	%	-	-	-	-
Effective Alkali charge as Na2O	%	-	-	-	-
AQ charge	%	-	-	-	-
Heating up time	min	90	90	90	90
Cooking time	min	240	240	240	240
Cooking temp.	°C	165	165	165	165
H Factor	-	2527,2	2527,2	2527,2	2527,2
Yield unscreened	%	74,20	70,30	67,90	63,60
Screen reject	%	negl.	negl.	negl.	negl.
Yield screened	%	74,20	70,30	67,90	63,60
Kappa No.		56,70	54,60	52,30	51,30

TABLE 14

Jute pulping **Alkaline sulphite AQ pulping at 165°C**

Laboratory: **Pulp and Paper Institute**
City: **Ljubliana**
Country: **Slovenia**
Conducted by: **IVA, Linz AUSTRIA , Dipl.Ing. Mohamed NAGA**
Date: **January-March 1995**
Client: **UNIDO, Vienna for Tribeni Mill**

	Unit							
Raw material		Jute	Jute	Jute	Jute	Jute	Jute	
Quality of Fiber								
Size of fiber	mm	250	250	250	250	250	250	
Pulping data								
Pulping Process		Alkal. Sulphite AQ	Alkal. Sulphite AQ	Alkal. Sulphite AQ	Alkal. Sulphite AQ	Alkal. Sulph. AQ	Alkal. Sulph. AQ	
Cook No.		ASAQ 01	ASAQ 02	ASAQ 03	ASAQ 04	ASAQ 05	ASAQ 05A	
Type of digester		Rotary, elect. heated	Rotary, elect. heated	Rotary, elect. heated	Rotary, elect. heated	Rotary, elect. heated	Rotary, elect. heated	
Size	l	10	10	10	10	10	10	
Hydromodul	1:??	3,00	3,00	3,00	3,00	3,00	3,00	
Raw material charge	g	340,91	340,91	340,91	340,91	454,55	454,55	
	gBD	300,00	300,00	300,00	300,00	400,00	400,00	
Dry content	%	88,00	88,00	88,00	88,00	88,00	88,00	
NaOH Charge	%	2,00	2,50	4,00	8,00	6,00	6,00	
Na2S Charge	%	-	-	-	-	-	-	
Sulfidity	%	-	-	-	-	-	-	
SO2 Charge	%	8,00	10,00	16,00	24,00	24,00	24,00	
Na2SO3 Charge	%	15,75	19,69	31,50	47,25	47,25	47,25	
Active Alkali charge as Na2O	%	-	-	-	-	-	-	
Effective Alkali charge as Na2O	%	-	-	-	-	-	-	
AQ charge	%	0,05	0,05	0,05	0,05	0,05	0,05	
Heating up time	min	90	90	90	90	90	90	
Cooking time	min	240	240	240	240	240	240	
Cooking temp.	°C	165	165	165	165	165	165	
H Factor	-	2527,2	2527,2	2527,2	2527,2	2527,2	2527,2	
Yield unscreened	%	71,90	71,60	64,50	62,10	62,00	62,10	62,07
Screen reject	%	negl.	negl.	negl.	negl.	negl.	negl.	
Yield screened	%	71,90	71,60	64,50	62,10	62,00	62,10	62,07
Kappa No.		46,80	41,90	27,10	18,00	21,30	19,00	19,43

TABLE 15

Jute pulping **Kraft pulping at 160°C**

Laboratory: **Pulp and Paper Institute**
City: **Ljubliana**
Country: **Slovenia**
Conducted by: **IVA, Linz AUSTRIA , Dipl.Ing. Mohamed NAGA**
Date: **January-March 1995**
Client: **UNIDO, Vienna for Tribeni Mill**

TABLE 15A

	Unit						
Raw material		Jute	Jute	Jute	Jute		
Quality of Fibre							
Size of fibre	mm	250	250	250	250		
Pulping data							
Pulping Process		Kraft	Kraft	Kraft	Kraft		
Cook No.		K 05	K 05A	K 05B	K 05C		
Type of digester		Rotary, elect. heated	Rotary, elect. heated	Rotary, elect. heated	Rotary, elect. heated		
Size	l	10	10	10	10		
Hydromodul		3,00	3,00	3,00	3,00		
Raw material charge	g	341	341	455	455		
	gBD	300	300	400	400		
Dry content	%	88,00	88,00	88,00	88,00		
NaOH Charge	%	12,51	12,51	12,51	12,51		
Na2S Charge	%	2,90	2,90	2,90	2,90		
Sulfidity	%	19,20	19,20	19,20	19,20		
SO2 Charge	%	-	-	-	-		
Na2SO3 Charge	%	-	-	-	-		
Active Alkali charge as Na2O	%	12,00	12,00	12,00	12,00		
Effective Alkali charge as Na2O	%	10,85	10,85	10,85	10,85		
AQ charge	%	-	-	-	-		
Heating up time	min	90	90	90	90		
Cooking time	min	120	120	120	120		
Cooking temp.	°C	160	160	160	160		
H Factor	-	860	860	860	860		
Yield unscreened	%	61,00	60,20	57,80	61,00	**Aver.**	**60,73**
Screen reject	%	negl.	negl.	negl.	negl.		
Yield screened	%	61,00	60,20	57,80	61,00	**Aver.**	**60,73**
Kappa No.		12,40	14,10	12,00	12,40	**Aver.**	**12,27**
Viscosity	ml/g			1029			
Brightness	% ISO				31,22		
Fibre fraction Bauer McNett:							
retained on mesh 14	%			88,40			
retained on mesh 30	%			7,50			
retained on mesh 50	%			2,00			
retained on mesh 100	%			0,50			
going through mesh 100	%			1,60			

NOTE: Cook no. K 05B used for physical propertie test, K 05C used for bleachability tests

TABLE 15B

Physical properties:		**Sample: from Cook No. K05B**				**KAPPA=**	**12,00**						
with PFI mill													
Beating point	-	0		1		2		3					
PFI revolution	rpm	1450		1450		1450		1450					
	rev.	0		4350		7250		11600		5141		8741	
	min	0,00		3,00		5,00		8,00		3,55		6,03	
Freeness	SR	17		27		38		73		30		50	
	CSF	656		470		333		72		428		224	
Grammage	g/m²	76,96		73,46		74,41		73,25		73,72		74,01	
Thickness	mm	0,174		0,128		0,119		0,106		0,126		0,115	
Density	kg/m³	440		575		625		690		589		647	
Bulk	m³/kg	2,273		1,739		1,600		1,449		1,701		1,548	
Stretch	%	1,7		2,8		3,3		3,9		2,9		3,5	
Breaking length	m	3745		6715		7010		10175		6795		8095	
Burst strength	kPa	146		320		350		398		328		366	
Tearing resistance	mN	1138		1067		930		776		1030		877	
MID double fold		15		470		784		478		556		679	
Tensile index	Nm/g	36,74		65,87		68,77		99,82		66,66		79,41	
Burst index	kPam²/g	1,90		4,36		4,70		5,43		4,45		4,95	
Tear index	mNm²/g	14,79		14,52		12,50		10,59		13,97		11,85	
Bendtsen porosity A/B side	ml/min	-	-	-	-	752	750	57	56	-	-	514	512
Bendtsen smoothness A/B side	ml/min	962	984	564	554	412	460	350	420	523	528	391	446
Zero beaten pulp:													
Fibre length Arithmetic average	mm	1,27											
Fibre length weighted average	mm	1,69											
Fibre diameter	mm	0,030											
Coarseness	mg/m	0,104											
Slenderness factor		16,3											
Fibre zero span tensile	km	1,13											
fibre zero span strength index	Nm/g	11,085											
Black liquor:													
pH		9,4											
Residual alkali as Na2O	g/l	5,27											
Viscosity at	RPM	20	50	100									
	mPa.S	12	14	19									
Dry solids content of org.liquor	%	17,0											
Organic content of dry solids	%	63,8											
Inorganic content of dry solids	%	36,2											
HHV of dry solids	kcal/kg	2889											
	kJ/kg	12097											
Specific gravity	g/cm³	1,10											

TABLE 16

Jute pulping **Kraft-AQ pulping at 160°C**

Laboratory: **Pulp and Paper Institute**
City: **Ljubliana**
Country: **Slovenia**
Conducted by: **IVA, Linz AUSTRIA , Dipl.Ing. Mohamed NAGA**
Date: **January-March 1995**
Client: **UNIDO, Vienna for Tribeni Mill**

TABLE 16A

	Unit						
Raw material		Jute	Jute	Jute	Jute		
Quality of Fibre							
Size of fibre	mm	250	250	250	250		
Pulping data							
Pulping Process		Kraft AQ	Kraft AQ	Kraft AQ	Kraft AQ		
Cook No.		KAQ05	KAQ05 A	KAQ05 B	KAQ05 C		
Type of digester		Rotary, elect. heated	Rotary, elect. heated	Rotary, elect. heated	Rotary, elect. heated		
Size	l	10	10	10	10		
Hydromodul		3,00	3,00	3,00	3,00		
Raw material charge	g	341	341	455	455		
	gBD	300	300	400	400		
Dry content	%	88,00	88,00	88,00	88,00		
NaOH Charge	%	12,51	12,51	12,51	12,51		
Na2S Charge	%	2,90	2,90	2,90	2,90		
Sulfidity	%	19,20	19,20	19,20	19,20		
SO2 Charge	%	-	-	-	-		
Na2SO3 Charge	%	-	-	-	-		
Active Alkali charge as Na2O	%	12,00	12,00	12,00	12,00		
Effective Alkali charge as Na2O	%	10,85	10,85	10,85	10,85		
AQ charge	%	0,05	0,05	0,05	0,05		
Heating up time	min	90	90	90	90		
Cooking time	min	120	120	120	120		
Cooking temp.	°C	160	160	160	160		
H Factor	-	860	860	860	860		
Yield unscreened	%	62,00	61,00	61,60	62,00	**Aver.**	**61,65**
Screen reject	%	negl.	negl.	negl.	negl.		
Yield screened	%	62,00	61,00	61,60	62,00	**Aver.**	**61,65**
Kappa No.		12,20	12,30	11,50	12,00	**Aver.**	**12,00**
Viscosity	ml/g			1045			
Brightness	% ISO				35,32		
Fibre fraction Bauer McNett:							
retained on mesh 14	%			84,30			
retained on mesh 30	%			18,20			
retained on mesh 50	%			2,40			
retained on mesh 100	%			0,70			
going through mesh 100	%			2,40			

NOTE: Cook no. KAQ 05B used for physical propertie test, KAQ 05C used for bleachability tests

TABLE 16B

Physical properties:		**Sample: from Cook No. KAQ05B**				**KAPPA=**	**11,50**						
with PFI mill													
Beating point	-	0		1		2		3					
PFI revolution	rpm	1450		1450		1450		1450					
	rev.	0		2900		4350		8700		4108		7411	
	min	0,00		2,00		3,00		6,00		2,83		5,11	
Freeness	SR	18		25		31		58		30		50	
	CSF	633		501		415		164		428		224	
Grammage	g/m²	74,84		74,30		76,00		74,41		75,72		74,88	
Thickness	mm	0,159		0,131		0,130		0,113		0,130		0,118	
Density	kg/m³	470		565		585		660		582		638	
Bulk	m³/kg	2,128		1,770		1,709		1,515		1,719		1,572	
Stretch	%	2,1		2,9		2,9		3,6		2,9		3,4	
Breaking length	m	5430		6900		7340		9070		7267		8557	
Burst strength	kPa	209		294		349		397		340		383	
Tearing resistance	mN	1303		1118		1098		596		1101		745	
MID double fold		112		469		749		496		702		571	
Tensile index	Nm/g	53,27		67,69		72,01		88,98		71,29		83,95	
Burst index	kPam²/g	2,79		3,96		4,59		5,34		4,49		5,11	
Tear index	mNm²/g	17,41		15,05		14,45		8,01		14,55		9,95	
Bendtsen porosity A/B side	ml/min	-	-	-	-	-	-	177	180	-	-	197	195
Bendtsen smoothness A/B side	ml/min	862	878	642	568	516	502	376	392	537	513	417	425

Zero beaten pulp:		
Fibre length Arithmetic average	mm	1,24
Fibre length weighted average	mm	1,68
Fibre diameter	mm	0,030
Coarseness	mg/m	0,100
Slenderness factor		16,8
Fibre zero span tensile	km	2,61
fibre zero span strength index	Nm/g	25,604
Black liquor:		
pH		9,3
Residual alkali as Na2O	g/l	4,68
Viscosity at	RPM	20
	mPa.S	15
Dry solids content of org.liquor	%	16,3
Organic content of dry solids	%	67,5
Inorganic content of dry solids	%	32,5
HHV of dry solids	kcal/kg	2997
	kJ/kg	12547
Specific gravity	g/cm³	1,10

		50	100
		16	20

TABLE 17

Jute pulping **Soda pulping at 160°C**

Laboratory: **Pulp and Paper Institute**
City: **Ljubliana**
Country: **Slovenia**
Conducted by: **IVA, Linz AUSTRIA , Dipl.Ing. Mohamed NAGA**
Date: **January-March 1995**
Client: **UNIDO, Vienna for Tribeni Mill**

TABLE 17A

	Unit				
Raw material		Jute	Jute	Jute	
Quality of Fibre					
Size of fibre	mm	250	250	250	
Pulping data					
Pulping Process		Soda	Soda	Soda	
Cook No.		S 05	S 05A	S 05B	
Type of digester		Rotary, elect. heated	Rotary, elect. heated	Rotary, elect. heated	
Size	l	10	10	10	
Hydromodul		3,00	3,00	3,00	
Raw material charge	g	341	455	455	
	gBD	300,00	400	400	
Dry content	%	88,00	88,00	88,00	
NaOH Charge	%	18,06	18,06	18,06	
Na2S Charge	%	0,00	0,00	0,00	
Sulfidity	%	0,00	0,00	0,00	
SO2 Charge	%	-	-	-	
Na2SO3 Charge	%	-	-	-	
Active Alkali charge as Na2O	%	14,00	14,00	14,00	
Effective Alkali charge as Na2O	%	14,00	14,00	14,00	
AQ charge	%	-	-	-	
Heating up time	min	90	90	90	
Cooking time	min	120	120	120	
Cooking temp.	°C	160	160	160	
H Factor	-	860	860	860	
Yield unscreened	%	58,30	57,80	58,30	**Aver. 58,13**
Screen reject	%	negl.	negl.	negl.	
Yield screened	%	58,30	57,80	58,30	**Aver. 58,13**
Kappa No.		12,90	17,60	12,90	**Aver. 14,47**
Viscosity	ml/g		1030		
Brightness	% ISO			37,31	
Fibre fraction Bauer McNett:					
retained on mesh 14	%		78,00		
retained on mesh 30	%		13,80		
retained on mesh 50	%		2,50		
retained on mesh 100	%		1,20		
going through mesh 100	%		4,50		

NOTE: Cook no. S 05A used for physical propertie test, S 05B used for bleachability tests

TABLE 17B

Physical properties:		**Sample: from Cook No. S05A**						**KAPPA= 17,60**					
with PFI mill													
Beating point	-	0		1		2		3					
PFI revolution	rpm	1450		1450		1450		1450					
	rev.	0		2900		4350		8700		4060		8483	
	min	0		2		3		6		2,80		5,85	
Freeness	SR	21		26		31		51		30		50	
	CSF	571		485		415		216		428		224	
Grammage	g/m²	77,60		75,69		75,90		75,37		75,86		75,40	
Thickness	mm	0,167		0,138		0,131		0,117		0,132		0,118	
Density	kg/m³	465		545		580		645		573		642	
Bulk	m³/kg	2,150		1,835		1,724		1,550		1,746		1,559	
Stretch	%	2,2		2,8		3,3		3,7		3,2		3,7	
Breaking length	m	3930		5590		5760		7020		5726		6957	
Burst strength	kPa	158		250		274		323		269		321	
Tearing resistance	mN	1267		1052		1032		914		1036		920	
MID double fold		35		416		871		1017		780		1010	
Tensile index	Nm/g	38,55		54,84		56,51		68,87		56,17		68,25	
Burst index	kPam²/g	2,04		3,30		3,61		4,29		3,55		4,25	
Tear index	mNm²/g	16,33		13,90		13,60		12,13		13,66		12,20	
Bendtsen porosity A/B side	ml/min	-	-	-	-	-	-	424	438	-	-	439	448
Bendtsen smoothness A/B side	ml/min	780	740	582	456	558	438	324	300	563	442	336	307
Zero beaten pulp:													
Fibre length Arithmetic average	mm	1,02											
Fibre length weighted average	mm	1,58											
Fibre diameter	mm	0,030											
Coarseness	mg/m	0,106											
Slenderness factor		14,9											
Fibre zero span tensile	km	2,60											
fibre zero span strength index	Nm/g	25,506											
Black liquor:													
pH		9,4											
Residual alkali as Na2O	g/l	8,76											
Viscosity at	RPM	20	50	100									
	mPa.S	10	13	19									
Dry solids content of org.liquor	%	14,7											
Organic content of dry solids	%	66,2											
Inorganic content of dry solids	%	33,8											
HHV of dry solids	kcal/kg	3296											
	kJ/kg	13799											
Specific gravity	g/cm³	1,09											

TABLE 18

Jute pulping **Soda-AQ pulping at 160°C**

Laboratory: **Pulp and Paper Institute**
City: **Ljubliana**
Country: **Slovenia**
Conducted by: **IVA, Linz AUSTRIA , Dipl.Ing. Mohamed NAGA**
Date: **January-March 1995**
Client: **UNIDO, Vienna for Tribeni Mill**

TABLE 18A

	Unit				
Raw material		Jute	Jute		
Quality of Fibre					
Size of fibre	mm	250	250		
Pulping data					
Pulping Process		Soda AQ	Soda AQ		
Cook No.		SAQ10	SAQ10 A		
Type of digester		Rotary, elect. heated	Rotary, elect. heated		
Size	l	10	10		
Hydromodul		3,00	3,00		
Raw material charge	g	455	455		
	gBD	400	400		
Dry content	%	88,00	88,00		
NaOH Charge	%	17,42	17,42		
Na2S Charge	%	0,00	0,00		
Sulfidity	%	0,00	0,00		
SO2 Charge	%	-	-		
Na2SO3 Charge	%	-	-		
Active Alkali charge as Na2O	%	13,50	13,50		
Effective Alkali charge as Na2O	%	13,50	13,50		
AQ charge	%	0,05	0,05		
Heating up time	min	90	90		
Cooking time	min	120	120		
Cooking temp.	°C	160	160		
H Factor	-	860	860		
Yield unscreened	%	60,10	60,10	**Aver.**	**60,10**
Screen reject	%	negl.	negl.		
Yield screened	%	60,10	60,10	**Aver.**	**60,10**
Kappa No.		11,70	10,20	**Aver.**	**10,95**
Viscosity	ml/g	1002			
Brightness	% ISO		40,87		
Fibre fraction Bauer McNett:					
retained on mesh 14	%	87,70			
retained on mesh 30	%	9,50			
retained on mesh 50	%	1,70			
retained on mesh 100	%	1,00			
going through mesh 100	%	0,10			

NOTE: Cook no. SAQ 10 used for physical propertie test, SAQ 10A used for bleachability tests

TABLE 18B

Physical properties:		Sample: from Cook No. SAQ 10				KAPPA= 11,70							
with PFI mill													
Beating point	-	0		1		2		3					
PFI revolution	rpm	1450		1450		1450		1450					
	rev.	0		4350		7250		10150		4350		8378	
	min	0		3		5		7		3,00		5,78	
Freeness	SR	18		30		43		61		30		50	
	CSF	633		428		284		144		428		224	
Grammage	g/m²	76,11		76,11		74,52		75,47		76,11		74,89	
Thickness	mm	0,163		0,130		0,119		0,113		0,130		0,117	
Density	kg/m³	465		585		625		665		585		641	
Bulk	m³/kg	2,150		1,709		1,600		1,504		1,709		1,563	
Stretch	%	2,2		3,4		3,7		3,8		3,4		3,7	
Breaking length	m	3980		6070		6380		6720		6070		6512	
Burst strength	kPa	180		306		341		378		306		355	
Tearing resistance	mN	1177		1146		1059		1059		1146		1059	
MID double fold		31		366		1853		1893		366		1869	
Tensile index	Nm/g	39,04		59,55		62,59		65,92		59,55		63,88	
Burst index	kPam²/g	2,36		4,02		4,58		5,01		4,02		4,75	
Tear index	mNm²/g	15,46		15,06		14,21		14,03		15,06		14,14	
Bendtsen porosity A/B side	ml/min	-	-	-	-	710	708	216	206	-	-	518	513
Bendtsen smoothness A/B side	ml/min	886	842	512	438	442	318	302	292	512	438	388	308

Zero beaten pulp:		
Fibre length Arithmetic average	mm	1,14
Fibre length weighted average	mm	1,760
Fibre diameter	mm	0,030
Coarseness	mg/m	0,101
Slenderness factor		17,4
Fibre zero span tensile	km	2,17
fibre zero span strength index	Nm/g	21,288
Black liquor:		
pH		9,4
Residual alkali as Na2O	g/l	6,44
Viscosity at	RPM	20
	mPa.S	10
Dry solids content of org.liquor	%	14,2
Organic content of dry solids	%	70,3
Inorganic content of dry solids	%	29,7
HHV of dry solids	kcal/kg	3388
	kJ/kg	14185
Specific gravity	g/cm³	1,08

50	100
13	19

TABLE 19

Jute pulping **Alkaline sulphite-AQ pulping at 165°C**

Laboratory: **Pulp and Paper Institute**
City: **Ljubliana**
Country: **Slovenia**
Conducted by: **IVA, Linz AUSTRIA , Dipl.Ing. Mohamed NAGA**
Date: **January-March 1995**
Client: **UNIDO, Vienna for Tribeni Mill**

TABLE 19A

	Unit				
Raw material		Jute	Jute	Jute	
Quality of Fibre					
Size of fibre	mm	250	250	250	
Pulping data					
Pulping Process		Alkal. Sulph.AQ	Alkal. Sulph. AQ	Alkal. Sulph. AQ	
Cook No.		ASAQ04	ASAQ 05	ASAQ 05A	
Type of digester		Rotary, elect. heated	Rotary, elect. heated	Rotary, elect. heated	
Size	l	10	10	10	
Hydromodul		3,00	3,00	3,00	
Raw material charge	g	341	455	455	
	gBD	300,00	400	400	
Dry content	%	88,00	88,00	88,00	
NaOH Charge	%	6,00	6,00	6,00	
Na2S Charge	%	-	-	-	
Sulfidity	%	-	-	-	
SO2 Charge	%	24,00	24,00	24,00	
Na2SO3 Charge	%	47,25	47,25	47,25	
Active Alkali charge as Na2O	%	-	-	-	
Effective Alkali charge as Na2O	%	-	-	-	
AQ charge	%	0,05	0,05	0,05	
Heating up time	min	90	90	90	
Cooking time	min	240	240	240	
Cooking temp.	°C	165	165	165	
H Factor	-	2527	2527	2527	
Yield unscreened	%	62,10	62,00	62,10	**Aver. 62,07**
Screen reject	%	negl.	negl.	negl.	
Yield screened	%	62,10	62,00	62,10	**Aver. 62,07**
Kappa No.		18,00	21,30	19,00	**Aver. 19,43**
Viscosity	ml/g	-	1302	-	
Brightness	% ISO			38,73	
Fibre fraction Bauer McNett:					
retained on mesh 14	%		78,90		
retained on mesh 30	%		13,00		
retained on mesh 50	%		2,50		
retained on mesh 100	%		1,10		
going through mesh 100	%		4,50		

NOTE: Cook no. ASAQ 05 used for physical propertie test, ASAQ 05A used for bleachability tests

TABLE 19B

Physical properties:		Sample: from Cook No. ASAQ 05 KAPPA= 21,30											
with PFI mill													
Beating point	-	0		1		2		3					
PFI revolution	rpm	1450		1450		1450		1450					
	rev.	0		4350		7250		10150		4086		8700	
	min	0		3		5		7		2,82		6,00	
Freeness	SR	18		31		42		58		30		50	
	CSF	633		415		293		164		428		224	
Grammage	g/m²	80,89		74,94		75,47		78,55		74,89		77,01	
Thickness	mm	0,168		0,115		0,109		0,107		0,116		0,108	
Density	kg/m³	480		650		690		735		646		713	
Bulk	m³/kg	2,450		1,538		1,449		1,360		1,546		1,405	
Stretch	%	2,4		4,2		4,3		4,8		4,2		4,6	
Breaking length	m	3880		6650		6870		8740		6630		7805	
Burst strength	kPa	161		366		418		486		361		452	
Tearing resistance	mN	1393		1295		1165		1165		1307		1165	
MID double fold		40		3317		3172		2735		3330		2954	
Tensile index	Nm/g	38,06		65,24		67,39		85,74		65,04		76,57	
Burst index	kPam²/g	1,99		4,88		5,54		6,19		4,82		5,87	
Tear index	mNm²/g	17,22		17,28		15,44		14,83		17,45		15,13	
Bendtsen porosity A/B side	ml/min	-	-	1048	1016	310	308	102	102	-	-	206	205
Bendtsen smoothness A/B side	ml/min	912	824	422	426	406	302	404	264	423	437	405	283
Zero beaten pulp:													
Fibre length Arithmetic average	mm	1,200											
Fibre length weighted average	mm	1,660											
Fibre diameter	mm	0,030											
Coarseness	mg/m	0,130											
Slenderness factor		12,8											
Fibre zero span tensile	km	6,79											
fibre zero span strength index	Nm/g	66,610											
Black liquor:													
pH		8,8											
Residual alkali as Na2O	g/l	4,49											
Viscosity at	RPM	20	50	100									
	mPa.S	15	16	22									
Dry solids content of org.liquor	%	22,3											
Organic content of dry solids	%	59,2											
Inorganic content of dry solids	%	40,8											
HHV of dry solids	kcal/kg	1821											
	kJ/kg	7626											
Specific gravity	g/cm³	1,16											

10.2 Bleachability tests

TABLE 20

Bleachability test **of kraft-jute-pulp**

Laboratory: **Pulp and Paper Institute**
City: **Ljubliana**
Country: **Slovenia**
Conducted by: **IVA, Linz AUSTRIA , Dipl.Ing. Mohamed NAGA**
Date: **March-April 1995**
Client: **UNIDO, Vienna for Tribeni Mill**

TABLE 20A

	Unit	
Pulping process		Kraft
Kappa No. unbleached		12,40
Initial Brightness	% ISO	31,22
Viscosity	ml/g	1029
Bleaching Sequence:		**C E H**
First Stage		**C**
HCl Charge	%	0,00
Sulfamic acid	%	0,00
Active Chlorine applied	%	3,00
Residual Chlorine	%	0,80
Active Chlorine consumed	%	2,20
Temperature	°C	20
Retention time	min	30
Consistency	%	3,00
pH start		
pH end		2,40
Second Stage		**E**
NaOH	%	1,50
Peroxid applied	%	0,00
Oxygen pressure	kg/cm²	
Temperature	°C	60
Retention time	min	90
Consistency	%	10,00
pH start		12,00
pH end		11,80
Third Stage		**H**
Sulfamic acid	%	0,00
Active Chlorine applied	%	1,50
Residual Chlorine	%	0,85
Active Chlorine consumed	%	0,65
NaOH as Buffer	%	0,00
Temperature	°C	40
Retention time	min	150
Consistency	%	10,00
pH start		11,80
pH end		9,90
Total Active Chlorine applied	%	4,50
Total Active Chlorine consumed	%	2,85
Final Brightness absolute	% ISO	76,50
Brigtness reversion	%	2,21

Viscosity	ml/g	662
Ash content	%	1,02
Bleaching yield	%	93,40
Unbleached yield average	%	60,73
Total yield bleached pulp	%	56,72
Classification of speks		
>5 mm²	speks/kgBD	-
1,0-4,99 mm²	speks/kgBD	679
0,4-0,99 mm²	speks/kgBD	1903
0,15-0,39 mm²	speks/kgBD	3807
Fiber fraction Bauer McNett:		
retained on mesh 14	%	67,00
retained on mesh 30	%	21,90
retained on mesh 50	%	3,40
retained on mesh 100	%	1,50
going through mesh 100	%	6,20

TABLE 20B

Physical properties:	**Unit**												
with PFI mill													
Beating point	-	0		1		2		3					
PFI revolution	rpm	1450		1450		1450		1450					
	rev.	0		4350		7250		11600		5141		11600	
	min	0,00		3,00		5,00		8,00		3,55		8,00	
Freeness	SR	19		27		38		50		30		50	
	CSF	611		470		333		224		428		224	
Grammage	g/m²	77,39		76,33		75,90		74,41		76,21		74,41	
Thickness	mm	0,163		0,134		0,123		0,118		0,131		0,118	
Density	kg/m³	475		570		615		630		582		630	
Bulk	m³/kg	2,105		1,754		1,626		1,587		1,719		1,587	
Stretch	%	2,4		2,9		3,6		3,7		3,1		3,7	
Breaking length	m	3425		5547		5854		6278		5631		6278	
Burst strength	kPa	146		283		288		307		284		307	
Tearing resistance	mN	1499		1353		1146		1118		1297		1118	
MID double fold		29		275		568		1114		355		1114	
Tensile index	Nm/g	33,60		54,42		57,43		61,59		55,24		61,59	
Burst index	kPam²/g	1,89		3,70		3,79		4,13		3,73		4,13	
Tear index	mNm²/g	19,37		17,73		15,10		15,02		17,01		15,02	
Bendtsen porosity A/B side	ml/min	-	-	-	-	912	902	582	560	3000	3000	582	560
Bendtsen smoothness A/B side	ml/min	935	788	656	556	466	404	422	354	604	515	422	354
Scattering coefficient	m²/kg	25,1	25,9	24,7	25,0	25,2	25,1	26,1	24,7	24,8	25,0	26,1	24,7
Opacity	%	82,5	82,2	80,9	81,1	81,5	81,3	81,7	81,3	81,1	81,2	81,7	81,3
Zero beaten pulp:													
Fibre length Arithmetic average	mm	1,100											
Fibre length weighted average	mm	1,60											
Fibre diameter	mm	0,030											
Coarseness	mg/m	0,102											
Slenderness factor		15,7											
Fibre zero span tensile	km	1,13											
fibre zero span strength index	Nm/g	11,1											

TABLE 21

Bleachability test **of kraft-AQ-jute-pulp**

Laboratory: **Pulp and Paper Institute**
City: **Ljubliana**
Country: **Slovenia**
Conducted by: **IVA, Linz AUSTRIA , Dipl.Ing. Mohamed NAGA**
Date: **March-April 1995**
Client: ***UNIDO, Vienna for Tribeni Mill***

TABLE 21A

	Unit	
Pulping process		Kraft-AQ
Kappa No. unbleached		12,00
Initial Brightness	% ISO	35,32
Viscosity	ml/g	1045
Bleaching Sequence:		**C E H**
First Stage		**C**
HCl Charge	%	0,00
Sulfamic acid	%	0,00
Active Chlorine applied	%	3,00
Residual Chlorine	%	1,90
Active Chlorine consumed	%	1,10
Temperature	°C	20
Retention time	min	30
Consistency	%	3,00
pH start		
pH end		2,40
Second Stage		**E**
NaOH	%	1,20
Peroxid applied	%	0,00
Oxygen pressure	kg/cm²	
Temperature	°C	60
Retention time	min	90
Consistency	%	10,00
pH start		11,50
pH end		11,00
Third Stage		**H**
Sulfamic acid	%	0,00
Active Chlorine applied	%	1,50
Residual Chlorine	%	0,70
Active Chlorine consumed	%	0,80
NaOH as Buffer	%	0,00
Temperature	°C	40
Retention time	min	150
Consistency	%	10,00
pH start		11,40
pH end		9,90
Total Active Chlorine applied	%	4,50
Total Active Chlorine consumed	%	1,90
Final Brightness absolute	% ISO	76,30

Brigtness reversion	%	2,14
Viscosity	ml/g	743
Ash content	%	0,84
Bleaching yield	%	93,00
Unbleached yield average	%	61,65
Total yield bleached pulp	%	57,33
Classification of speks		
>5 mm²	speks/kgBD	-
1,0-4,99 mm²	speks/kgBD	384
0,4-0,99 mm²	speks/kgBD	1119
0,15-0,39 mm²	speks/kgBD	2175
Fiber fraction Bauer McNett:		
retained on mesh 14	%	81,80
retained on mesh 30	%	11,00
retained on mesh 50	%	2,40
retained on mesh 100	%	1,10
going through mesh 100	%	3,70

TABLE 21B

Physical properties:	**Unit**												
with PFI mill													
Beating point	-	0		1		2		3					
PFI revolution	rpm	1450		1450		1450		1450					
	rev.	0		4350		7250		14500		7250		11927	
	min	0,00		3,00		5,00		10,00		5,00		8,23	
Freeness	SR	17		25		30		61		30		50	
	CSF	656		501		428		144		428		224	
Grammage	g/m²	74,30		75,05		76,85		74,63		76,85		75,42	
Thickness	mm	0,149		0,133		0,126		0,111		0,126		0,116	
Density	kg/m³	440		565		605		680		605		653	
Bulk	m³/kg	2,272		1,770		1,633		1,470		1,633		1,528	
Stretch	%	2,1		3,4		3,4		4,1		3,4		3,9	
Breaking length	m	2976		5283		5447		5984		5447		5793	
Burst strength	kPa	117		242		276		313		276		300	
Tearing resistance	mN	1126		1451		1538		969		1538		1171	
MID double fold		14		149		622		1427		622		1141	
Tensile index	Nm/g	29,19		51,83		53,44		58,70		53,44		56,83	
Burst index	kPam²/g	1,57		3,22		3,59		4,19		3,59		3,98	
Tear index	mNm²/g	15,15		19,33		20,01		12,98		20,01		15,53	
Bendtsen porosity A/B side	ml/min	-	-	-	-	-	-	171	168	3000	3000	171	168
Bendtsen smoothness A/B side	ml/min	916	825	570	442	486	360	334	268	486	360	388	301
Scattering coefficient	m²/kg	24,7	24,1	23,7	24,2	24,3	24,3	24,2	24,2	24,3	24,3	24,2	24,2
Opacity	%	81,3	81,6	80,1	80,7	80,9	81,2	80,9	81,0	80,9	81,2	80,9	81,1
Zero beaten pulp:													
Fibre length Arithmetic average	mm	1,21											
Fibre length weighted average	mm	1,71											
Fibre diameter	mm	0,030											
Coarseness	mg/m	0,129											
Slenderness factor		13,3											
Fibre zero span tensile	km	1,27											
fibre zero span strength index	Nm/g	12,5											

TABLE 22

Bleachability test **of soda-jute-pulp**

Laboratory: **Pulp and Paper Institute**
City: **Ljubliana**
Country: **Slovenia**
Conducted by: **IVA, Linz AUSTRIA , Dipl.Ing. Mohamed NAGA**
Date: **March-April 1995**
Client: **UNIDO, Vienna for Tribeni Mill**

TABLE 22

	Unit	
Pulping process		Soda
Kappa No. unbleached		12,50
Initial Brightness	% ISO	37,31
Viscosity	ml/g	1030
Bleaching Sequence:		**C E H**
First Stage		**C**
HCl Charge	%	0,00
Sulfamic acid	%	0,00
Active Chlorine applied	%	2,60
Residual Chlorine	%	1,31
Active Chlorine consumed	%	1,29
Temperature	°C	20
Retention time	min	30
Consistency	%	3,00
pH start		
pH end		2,30
Second Stage		**E**
NaOH	%	1,20
Peroxid applied	%	0,00
Oxygen pressure	kg/cm²	
Temperature	°C	60
Retention time	min	90
Consistency	%	10,00
pH start		11,70
pH end		11,30
Third Stage		**H**
Sulfamic acid	%	0,00
Active Chlorine applied	%	1,50
Residual Chlorine	%	0,58
Active Chlorine consumed	%	0,92
NaOH as Buffer	%	
Temperature	°C	40
Retention time	min	150
Consistency	%	10,00
pH start		11,23
pH end		10,05
Total Active Chlorine applied	%	4,10
Total Active Chlorine consumed	%	2,21
Final Brightness absolute	% ISO	76,90
Brigtness reversion	%	2,65

Viscosity	ml/g	660
Ash content	%	0,52
Bleaching yield	%	93,60
Unbleached yield average	%	58,13
Total yield bleached pulp	%	54,41
Classification of speks		
>5 mm²	speks/kgBD	-
1,0-4,99 mm²	speks/kgBD	333
0,4-0,99 mm²	speks/kgBD	832
0,15-0,39 mm²	speks/kgBD	1197
Fiber fraction Bauer McNett:		
retained on mesh 14	%	73,00
retained on mesh 30	%	16,20
retained on mesh 50	%	3,10
retained on mesh 100	%	5,40
going through mesh 100	%	

TABLE 22B

Physical properties:	**Unit**												
with PFI mill													
Beating point	-	0		1		2		3					
PFI revolution	rpm	1450		1450		1450		1450					
	rev.	0		4350		7250		10150		5179		9321	
	min	0,00		3,00		5,00		7,00		3,57		6,43	
Freeness	SR	16		26		40		54		30		50	
	CSF	680		485		313		193		428		224	
Grammage	g/m²	74,52		74,73		76,11		75,05		75,12		75,35	
Thickness	mm	0,171		0,136		0,125		0,116		0,133		0,119	
Density	kg/m³	435		545		605		645		562		634	
Bulk	m³/kg	2,299		1,835		1,653		1,550		1,783		1,579	
Stretch	%	1,7		2,7		3,1		3,3		2,8		3,2	
Breaking length	m	2807		4126		4967		5135		4366		5087	
Burst strength	kPa	104		192		233		247		204		243	
Tearing resistance	mN	765		890		694		659		834		669	
MID double fold		5		26		33		100		28		81	
Tensile index	Nm/g	27,54		40,48		48,73		50,37		42,83		49,90	
Burst index	kPam²/g	1,40		2,57		3,06		3,29		2,71		3,22	
Tear index	mNm²/g	10,27		11,91		9,10		8,78		11,10		8,88	
Bendtsen porosity A/B side	ml/min	-	-	-	-	-	-	652	648	3000	3000	652	648
Bendtsen smoothness A/B side	*ml/min*	936	890	612	500	518	374	428	310	585	464	454	328
Scattering coefficient	m²/kg	26,0	26,1	24,8	25,3	25,6	25,7	25,9	25,3	25,0	25,4	25,8	25,4
Opacity	%	82,9	82,7	81,5	81,4	82,1	82,3	82,5	82,3	81,7	81,7	82,4	82,3
Zero beaten pulp:													
Fibre length Arithmetic average	mm	0,720											
Fibre length weighted average	mm	1,460											
Fibre diameter	mm	0,030											
Coarseness	mg/m	0,109											
Slenderness factor		13,4											
Fibre zero span tensile	km	1,83											
fibre zero span strength index	*Nm/g*	18,0											

TABLE 23

Bleachability test **of soda-AQ-jute-pulp**

Laboratory: **Pulp and Paper Institute**
City: **Ljubliana**
Country: **Slovenia**
Conducted by: **IVA, Linz AUSTRIA , Dipl.Ing. Mohamed NAGA**
Date: **March-April 1995**
Client: **UNIDO, Vienna for Tribeni Mill**

TABLE 23A

	Unit	
Pulping process		Soda-AQ
Kappa No. unbleached		10,20
Initial Brightness	% ISO	40,87
Viscosity	ml/g	1002
Bleaching Sequence:		**C E H**
First Stage		**C**
HCl Charge	%	0,00
Sulfamic acid	%	0,00
Active Chlorine applied	%	2,04
Residual Chlorine	%	1,60
Active Chlorine consumed	%	0,44
Temperature	°C	20
Retention time	min	30
Consistency	%	3,00
pH start		
pH end		2,45
Second Stage		**E**
NaOH	%	1,20
Peroxid applied	%	0,00
Oxygen pressure	kg/cm²	
Temperature	°C	60
Retention time	min	90
Consistency	%	10,00
pH start		12,00
pH end		10,80
Third Stage		**H**
Sulfamic acid	%	0,00
Active Chlorine applied	%	1,50
Residual Chlorine	%	0,73
Active Chlorine consumed	%	0,77
NaOH as Buffer	%	0,00
Temperature	°C	40
Retention time	min	150
Consistency	%	10,00
pH start		11,55
pH end		10,10
Total Active Chlorine applied	%	3,54
Total Active Chlorine consumed	%	1,21
Final Brightness absolute	% ISO	74,40

Brigtness reversion	%	2,37
Viscosity	ml/g	691
Ash content	%	0,62
Bleaching yield	%	93,70
Unbleached yield average	%	60,10
Total yield bleached pulp	%	56,31
Classification of speks		
>5 mm²	speks/kgBD	-
1,0-4,99 mm²	speks/kgBD	660
0,4-0,99 mm²	speks/kgBD	1814
0,15-0,39 mm²	speks/kgBD	6596
Fiber fraction Bauer McNett:		
retained on mesh 14	%	
retained on mesh 30	%	
retained on mesh 50	%	
retained on mesh 100	%	
going through mesh 100	%	

TABLE 23B

Physical properties:	**Unit**												
with PFI mill													
Beating point	-	0		1		2		3					
PFI revolution	rpm	1450		1450		1450		1450					
	rev.	0		4350		7250		11600		5961		10730	
	min	0,00		3,00		5,00		8,00		4,11		7,40	
Freeness	SR	17		25		34		54		30		50	
	CSF	656		501		378		193		428		224	
Grammage	g/m²	74,20		75,69		75,80		74,52		75,75		74,78	
Thickness	mm	0,171		0,137		0,127		0,114		0,131		0,117	
Density	kg/m³	435		550		595		655		575		643	
Bulk	m³/kg	2,293		1,818		1,681		1,531		1,742		1,561	
Stretch	%	1,7		2,6		3,1		3,7		2,9		3,6	
Breaking length	m	2737		4703		5043		5789		4892		5640	
Burst strength	kPa	101		199		234		272		218		264	
Tearing resistance	mN	844		949		981		757		967		802	
MID double fold		5		52		91		183		74		165	
Tensile index	Nm/g	26,85		46,14		49,47		56,79		47,99		55,33	
Burst index	kPam²/g	1,36		2,63		3,09		3,65		2,88		3,54	
Tear index	mNm²/g	11,37		12,54		12,94		10,16		12,76		10,72	
Bendtsen porosity A/B side	ml/min	-	-	-	-	-	-	536	530	3000	3000	536	530
Bendtsen smoothness A/B side	ml/min	942	922	608	510	562	388	428	370	582	442	455	374
Scattering coefficient	m²/kg	25,4	26,2	24,6	24,6	25,0	25,4	25,3	25,2	24,8	25,0	25,2	25,2
Opacity	%	82,9	83,3	82,1	82,0	80,3	82,7	83,0	82,8	81,1	82,4	82,5	82,8
Zero beaten pulp:													
Fibre length Arithmetic average	mm	0,88											
Fibre length weighted average	mm	1,54											
Fibre diameter	mm	0,030											
Coarseness	mg/m	0,108											
Slenderness factor		14,3											
Fibre zero span tensile	km	1,95											
fibre zero span strength index	Nm/g	19,1											

TABLE 24

Bleachability test **of alkali sulphite-AQ-jute-pulp**

Laboratory: **Pulp and Paper Institute**
City: **Ljubliana**
Country: **Slovenia**
Conducted by: **IVA, Linz AUSTRIA , Dipl.Ing. Mohamed NAGA**
Date: **March-April 1995**
Client: **UNIDO, Vienna for Tribeni Mill**

TABLE 24A

	Unit	
Pulping process		Alkali Sulphite-AQ
Kappa No. unbleached		19,00
Initial Brightness	% ISO	38,73
Viscosity	ml/g	1302
Bleaching Sequence:		**C E H**
First Stage		**C**
HCl Charge	%	0,00
Sulfamic acid	%	0,00
Active Chlorine applied	%	3,80
Residual Chlorine	%	1,26
Active Chlorine consumed	%	2,54
Temperature	°C	20
Retention time	min	30
Consistency	%	3,00
pH start		
pH end		2,10
Second Stage		**E**
NaOH	%	1,20
Peroxid applied	%	0,00
Oxygen pressure	kg/cm²	
Temperature	°C	60
Retention time	min	90
Consistency	%	10,00
pH start		11,90
pH end		11,40
Third Stage		**H**
Sulfamic acid	%	0,00
Active Chlorine applied	%	1,50
Residual Chlorine	%	0,84
Active Chlorine consumed	%	0,66
NaOH as Buffer	%	0,00
Temperature	°C	40
Retention time	min	150
Consistency	%	10,00
pH start		11,30
pH end		10,00
Total Active Chlorine applied	%	5,30
Total Active Chlorine consumed	%	3,20

Final Brightness absolute	% ISO	83,40
Brigtness reversion	%	1,81
Viscosity	ml/g	1051
Ash content	%	0,88
Bleaching yield	%	94,10
Unbleached yield average	%	62,07
Total yield bleached pulp	%	58,40
Classification of speks		
>5 mm²	speks/kgBD	-
1,0-4,99 mm²	speks/kgBD	691
0,4-0,99 mm²	speks/kgBD	1613
0,15-0,39 mm²	speks/kgBD	4839
Fiber fraction Bauer McNett:		
retained on mesh 14	%	73,00
retained on mesh 30	%	14,80
retained on mesh 50	%	2,60
retained on mesh 100	%	1,20
going through mesh 100	%	8,40

TABLE 24B

Physical properties:	**Unit**												
with PFI mill													
Beating point	-	0		1		2		3					
PFI revolution	rpm	1450		1450		1450		1450					
	rev.	0		4350		7250		13050		6888		12041	
	min	0,00		3,00		5,00		9,00		4,75		8,30	
Freeness	SR	18		23		31		54		30		50	
	CSF	633		535		415		193		428		224	
Grammage	g/m²	77,49		75,05		76,00		76,00		75,88		76,00	
Thickness	mm	0,166		0,125		0,118		0,110		0,119		0,111	
Density	kg/m³	465		600		645		690		639		682	
Bulk	m³/kg	2,151		1,666		1,550		1,449		1,565		1,467	
Stretch	%	2,3		3,4		4,1		4,2		4,0		4,2	
Breaking length	m	2713		5449		6955		7390		6767		7314	
Burst strength	kPa	128		288		324		386		320		375	
Tearing resistance	mN	969		1668		1460		1315		1486		1340	
MID double fold		14		2470		1981		2020		2042		2013	
Tensile index	Nm/g	26,61		53,45		68,23		72,50		66,38		71,75	
Burst index	kPam²/g	1,65		3,84		4,26		5,08		4,21		4,94	
Tear index	mNm²/g	12,50		22,23		19,21		17,30		19,58		17,63	
Bendtsen porosity A/B side	ml/min	-	-	-	-	-	-	224	211	3000	3000	224	211
Bendtsen smoothness A/B side	ml/min	860	838	604	451	464	394	456	322	482	401	457	335
Scattering coefficient	m²/kg	25,1	25,6	21,4	21,5	22,4	21,6	21,6	21,9	22,3	21,6	21,7	21,8
Opacity	%	80,5	80,6	76,5	76,0	77,6	76,8	77,2	77,5	77,5	76,7	77,3	77,4

Zero beaten pulp:		
Fibre length Arithmetic average	mm	1,15
Fibre length weighted average	mm	1,65
Fibre diameter	mm	0,030
Coarseness	mg/m	0,118
Slenderness factor		14,0
Fibre zero span tensile	km	7,13
fibre zero span strength index	Nm/g	69,9

10.3 Bench scale and pilot plant pulping tests at CPPRI

TABLE 25

Jute pulping **Kraft pulping at 160°C, 12 % AA, 2 h**

Laboratory: **Central Pulp and Paper Research Institute**
City: **Saharanpur**
Country: **India**
Conducted by:
Date: **18.4.1995**

TABLE 25A

	Unit				
Raw material		Jute	Jute	Jute	Jute
Quality of Fibre					
Size of fibre	mm	75	75	75	75
Pulping data					
Pulping Process		Kraft	Kraft	Kraft	Kraft
Cook No.		1	2	3	Avg.
Type of digester		Rotary, elect. heated	Rotary, elect. heated	Rotary, elect. heated	Rotary, elect. heated
Size	l	2,5	2,5	2,5	2,5
Hydromodul		3,00	3,00	3,00	3,00
Raw material charge	g				
	gBD	200	200	200	200
Dry content	%				
NaOH Charge	%	12,39	12,39	12,39	12,39
Na2S Charge	%	3,02	3,02	3,02	3,02
Sulfidity	%	20,00	20,00	20,00	20,00
SO2 Charge	%	-	-	-	-
Na2SO3 Charge	%	-	-	-	-
Active Alkali charge as Na2O	%	12,00	12,00	12,00	12,00
Effective Alkali charge as Na2O	%	10,80	10,80	10,80	10,80
AQ charge	%	0,00	0,00	0,00	0,00
Heating up time	min	90	90	90	90
Cooking time	min	120	120	120	120
Cooking temp.	°C	160	160	160	160
H Factor	-	860	860	860	860
Yield unscreened	%	62,26	60,32	62,30	61,63
Kappa No.		14,30	14,90	15,00	14,73
Viscosity	ml/g				1080
	csp				56
Brightness	%				29,4

TABLE 25B

Physical properties: **Sample: from Cook No. 1-3** **KAPPA=** **14,73**

with PFI mill					
Beating point	-	0	1		
PFI revolution	rpm	1450	1450		
	rev.	0	4000	1500	3500
	min	0,00	2,76	1,03	2,41
Freeness	SR	15	55	30	50
	CSF	706	656	656	656
Grammage	g/m²	64,40	63,50	64,06	63,61
Density	kg/m³	470	740	571	706
Stretch	%	3,7	3,8	3,7	3,8
Breaking length	m	5097	10398	7085	9735
Burst strength	kPa	135	435	248	398
Tearing resistance	mN	892	721	828	742
Tensile index	Nm/g	50,00	102,00	69,50	95,50
Burst index	kPam²/g	2,10	6,85	3,88	6,26
Tear index	mNm²/g	13,85	11,35	12,91	11,66
Bendtsen porosity	ml/min	3000	140	1928	498
Black liquor:					
pH		11,5			
Residual alkali as Na2O	g/l	8,99			
Dry solids content of org.liquor	%	9,9			

TABLE 26

Jute pulping **Kraft-AQ pulping at 160°C, 12 % AA, 2 h**

Laboratory: **Central Pulp and Paper Research Institute**
City: **Saharanpur**
Country: **India**
Conducted by:
Date: **18.4.1995**

TABLE 26A

	Unit				
Raw material		Jute	Jute	Jute	Jute
Quality of Fibre					
Size of fibre	mm	75	75	75	75
Pulping data					
Pulping Process		Kraft AQ	Kraft AQ	Kraft AQ	Kraft AQ
Cook No.		4	5	6	Avg.
Type of digester		Rotary, elect. heated	Rotary, elect. heated	Rotary, elect. heated	Rotary, elect. heated
Size	l	2,5	2,5	2,5	2,5
Hydromodul		3,00	3,00	3,00	3,00
Raw material charge	g				
	gBD	200	200	200	200
Dry content	%				
NaOH Charge	%	12,39	12,39	12,39	12,39
Na2S Charge	%	3,02	3,02	3,02	3,02
Sulfidity	%	20,00	20,00	20,00	20,00
SO2 Charge	%	-	-	-	-
Na2SO3 Charge	%	-	-	-	-
Active Alkali charge as Na2O	%	12,00	12,00	12,00	12,00
Effective Alkali charge as Na2O	%	10,80	10,80	10,80	10,80
AQ charge	%	0,05	0,05	0,05	0,05
Heating up time	min	90	90	90	90
Cooking time	min	120	120	120	120
Cooking temp.	°C	160	160	160	160
H Factor	-	860	860	860	860
Yield unscreened	%	60,39	62,05	61,19	61,21
Kappa No.		13,60	13,50	13,60	13,57
Viscosity	ml/g				1050
Brightness	%				33,1

TABLE 26B

Physical properties: **Sample: from Cook No. 1-3** **KAPPA=** **13,57**

with PFI mill					
Beating point	-	0	1		
PFI revolution	rpm	1450	1450		
	rev.	0	4000	1463	3415
	min	0,00	2,76	1,01	2,35
Freeness	SR	15	56	30	50
	CSF	706	178	428	224
Grammage	g/m²	66,60	62,20	64,99	62,84
Density	kg/m³	470	720	561	683
Stretch	%	1,8	3,9	2,6	3,6
Breaking length	m	4485	11111	6909	10141
Burst strength	kPa	120	476	250	424
Tearing resistance	mN	932	678	839	715
Tensile index	Nm/g	44,00	109,00	67,78	99,49
Burst index	kPam²/g	1,80	7,65	3,94	6,79
Tear index	mNm²/g	14,00	10,90	12,87	11,35
Bendtsen porosity	ml/min	3000	60	1924	490
Black liquor:					
pH		11,5			
Residual alkali as Na2O	g/l	8,99			
Dry solids content of org.liquor	%	15,23			

TABLE 27

Jute pulping **Kraft pulping at 160°C,12% AA, 3h**

Pilot plant: **Central Pulp and Paper Research Institute**
City: **Saharanpur**
Country: **India**
Conducted by:
Date: **24.4.1995**

TABLE 27A

	Unit	
Raw material		Jute
Quality of Fibre		
Size of fibre	mm	75
Pulping data		
Pulping Process		Kraft
Cook No.		PP01
Type of digester		Pilot Plant
Size	m^3	11
Hydromodul		2,50
Raw material charge	kg	560
	kgBD	500
Dry content	%	89,29
NaOH Charge	%	12,39
Na2S Charge	%	3,02
Sulfidity	%	20,00
SO2 Charge	%	-
Na2SO3 Charge	%	-
Active Alkali charge as Na2O	%	12,00
Effective Alkali charge as Na2O	%	10,80
AQ charge	%	0,00
Heating up time	min	90
Cooking time	min	180
Cooking temp.	°C	160
H Factor	-	1257
Kappa No.		10,60
Viscosity	ml/g	610
	cps	
Brightness	%	29,6

9,30 tested at TTD

33,00

38,10

TABLE 27B

Physical properties:	**Sample: from Cook No**			**PP01**		**KAPPA= 10,60**		tested at TTD			
with PFI mill								**KAPPA= 9,30**			
Beating point	-	0	1	2	3			0	1	2	
PFI revolution	rpm	1450	1450	1450	1450				1450	1450	
	rev.	0	2000	4000	6000	2400	4696		7000	11000	7444
	min	0,00	1,38	2,76	4,14	1,66	3,24		4,83	7,59	5,13
Freeness	SR	15	27	42	65	30	50	18	47	74	50
	CSF	706	470	293	119	428	224	633	248	67	224
Drainage time	s	4,5	5,0	6,5	13,5	5,30	8,93				
Grammage	g/m²	68,30	62,30	65,00	62,40	62,84	64,10		75,00	75,00	75,00
Thickness	mm										
Density	kg/m³	460	610	700	750	628	717		590	650	597
Bulk	m³/kg										
Stretch	%	2,2	2,6	3,1	3,7	2,7	3,3		2,88	2,67	2,86
Breaking length	m	3721	6830	7441	7085	6952	7317		6017	6777	6101
Burst strength	kPa	99	212	270	253	223	264		272	288	274
Tearing resistance	mN	826	455	400	346	444	381		644	602	639
MID double fold											
Tensile index	Nm/g	36,50	67,00	73,00	69,50	68,20	71,78		59,03	66,48	59,86
Burst index	kPam²/g	1,45	3,40	4,15	4,05	3,56	4,12		3,63	3,84	3,65
Tear index	mNm²/g	12,10	7,30	6,15	5,55	7,06	5,95		8,58	8,03	8,52
Bendtsen porosity	ml/min	3000	2810	720	130	2392	515		1127	271	1032
Bendtsen smoothness	ml/min										

Zero beaten pulp:		
Fibre length Arithmetic average	mm	1,10
Fibre length weighted average	mm	1,61
Fibre diameter	mm	
Coarseness	mg/m	0,105
Slenderness factor		15,3
Fibre zero span tensile	km	
fibre zero span strength index	Nm/g	

Black liquor:				
pH		11,6		
Residual alkali as Na2O	g/l	8,20		
Viscosity at	RPM	20	50	100
	mPa.S			2
Dry solids content of org.liquor	%	13,2		
Organic content of dry solids	%	35,4		
Inorganic content of dry solids	%	64,6		
HHV of dry solids	kcal/kg	2478		
	kJ/kg	10375		

TABLE 28

Jute pulping **Kraft pulping at 160°C,11,5% AA, 2h**

Pilot plant: **Central Pulp and Paper Research Institute**
City: **Saharanpur**
Country: **India**
Conducted by:
Date: **23.5.1995**

TABLE 28A

	Unit	
Raw material		Jute
Quality of Fibre		
Size of fibre	mm	250
Pulping data		
Pulping Process		Kraft
Cook No.		PP05
Type of digester		Pilot Plant
Size	m^3	11
Hydromodul		2,50
Raw material charge	kg	
	kgBD	300
Dry content	%	
NaOH Charge	%	11,87
Na2S Charge	%	2,89
Sulfidity	%	20,00
SO2 Charge	%	-
Na2SO3 Charge	%	-
Active Alkali charge as Na2O	%	11,50
Effective Alkali charge as Na2O	%	10,35
AQ charge	%	0,00
Heating up time	min	90
Cooking time	min	120
Cooking temp.	°C	160
H Factor	-	860
Kappa No.		13,60
Viscosity	ml/g	1010
	cps	
Brightness	%	

13,00 tested at TTD

62,70

31,00

TABLE 28B

Physical properties:		Sample: from Cook No KAPPA= 13,60			PP05	tested at TTD KAPPA= 13,00					
with PFI mill											
Beating point	-	0				0	1	2	3		
PFI revolution	rpm					1450	1450	1450	1450		
	rev.					0	4000	8000	12000	2824	6143
	min					0,00	2,76	5,52	8,28	2,27	4,24
Freeness	SR					18	35	63	82	30	50
	CSF					633	366	131	26	428	224
Drainage time	s										
Grammage	g/m²					75,00	75,00	75,00	75,00	75,00	75,00
Thickness	mm										
Density	kg/m³					460	580	610	640	545	596
Bulk	m³/kg										
Stretch	%					2,27	3,43	3,17	3,54	3,09	3,29
Breaking length	m					3662	6548	7171	8532	5699	6882
Burst strength	kPa					162	357	394	432	300	377
Tearing resistance	mN					1200	908	848	885	994	875
MID double fold											
Tensile index	Nm/g					38,90	64,20	70,40	83,70	56,76	67,52
Burst index	kPam²/g					2,16	4,76	5,25	5,76	4,00	5,02
Tear index	mNm²/g					16,00	12,10	11,30	11,80	13,25	11,67
Bendtsen porosity A/B side	ml/min					1443	711	181	53	926	427
Bendtsen smoothness A/B side	ml/min										

Zero beaten pulp:		
Fibre length Arithmetic average	mm	1,20
Fibre length weighted average	mm	1,61
Fibre diameter	mm	
Coarseness	mg/m	0,148
Slenderness factor		10,9
Fibre zero span tensile	km	
fibre zero span strength index	Nm/g	
Dirt cont acc. TAPPI	mm²/m²	235

Black liquor:		
pH		11,6
Residual alkali as Na2O	g/l	4,90
Dry solids content of org.liquor	%	12,04
Organic content of dry solids	%	30,9
Inorganic content of dry solids	%	69,1
HHV of dry solids	kcal/kg	3200
	kJ/kg	13398

TABLE 29

Jute pulping **Kraft pulping at 160°C,11,5% AA, 2h**

Pilot plant: **Central Pulp and Paper Research Institute**
City: **Saharanpur**
Country: **India**
Conducted by:
Date: **25.5.1995**

TABLE 29A

	Unit	
Raw material		Jute
Quality of Fibre		
Size of fibre	mm	250
Pulping data		
Pulping Process		Kraft
Cook No.		PP06
Type of digester		Pilot Plant
Size	m^3	11
Hydromodul		2,50
Raw material charge	kg	
	kgBD	1500
Dry content	%	
NaOH Charge	%	11,87
Na2S Charge	%	2,89
Sulfidity	%	20,00
SO2 Charge	%	-
Na2SO3 Charge	%	-
Active Alkali charge as Na2O	%	11,50
Effective Alkali charge as Na2O	%	10,35
AQ charge	%	0,00
Heating up time	min	90
Cooking time	min	120
Cooking temp.	°C	160
H Factor	-	860
Kappa No.		17,00
Viscosity	ml/g	1100
	cps	
Brightness	%	

14,70 tested at TTD

103,80

37,30

TABLE 29B

Physical properties: **Sample: from Cook No** **PP06** tested at TTD

KAPPA= 0,00

with PFI mill					**KAPPA= 14,70**					
Beating point	-	0			0	1	2	3		
PFI revolution	rpm				1450	1450	1450	1450		
	rev.				0	4000	8000	12000	4000	7636
	min				0,00	2,76	5,52	8,28	2,76	5,27
Freeness	SR				18	30	52	74	30	50
	CSF				633	428	208	67	428	224
Drainage time	s									
Grammage	g/m²				75,00	75,00	75,00	75,00	75,00	75,00
Thickness	mm									
Density	kg/m³				470	530	560	620	530	557
Bulk	m³/kg									
Stretch	%				2,54	3,38	3,67	3,71	3,38	3,64
Breaking length	m				3362	6633	7365	8073	6633	7298
Burst strength	kPa				157	347	439	447	347	430
Tearing resistance	mN				1137	1099	1021	1010	1099	1028
MID double fold										
Tensile index	Nm/g				32,98	65,07	72,25	79,20	65,07	71,60
Burst index	kPam²/g				2,09	4,63	5,85	5,96	4,63	5,74
Tear index	mNm²/g				15,16	14,65	13,61	13,46	14,65	13,70
Bendtsen porosity	ml/min				3000	1425	441	121	1425	530
Bendtsen smoothness	ml/min									

Zero beaten pulp:			
Fibre length Arithmetic average	mm		1,13
Fibre length weighted average	mm		1,55
Fibre diameter	mm		
Coarseness	mg/m		0,135
Slenderness factor			11,5
Dirt cont acc. TAPPI	mm²/m²		149

TABLE 30

Jute pulping **Kraft-AQ pulping at 160°C 12% AA, 3h**

Pilot plant: ***Central Pulp and Paper Research Institute***
City: **Saharanpur**
Country: **India**
Conducted by:
Date: **25.4.1995**

TABLE 30A

	Unit	
Raw material		Jute
Quality of Fibre		
Size of fibre	mm	75
Pulping data		
Pulping Process		Kraft AQ
Cook No.		PP02
Type of digester		Pilot Plant
Size	m^3	11
Hydromodul		2,50
Raw material charge	kg	560
	kgBD	500
Dry content	%	89,29
NaOH Charge	%	12,39
Na2S Charge	%	3,02
Sulfidity	%	20,00
SO2 Charge	%	-
Na2SO3 Charge	%	-
Active Alkali charge as Na2O	%	12,00
Effective Alkali charge as Na2O	%	10,80
AQ charge	%	0,05
Heating up time	min	90
Cooking time	min	180
Cooking temp.	°C	160
H Factor	-	1257
Kappa No.		10,40
Viscosity	ml/g	690
	cps	
Brightness	%	29,6

9,30 tested at TTD

32,00

38,47

TABLE 30B

Physical properties:	Sample: from Cook No			PP02		KAPPA= 10,40		tested at TTD			
								KAPPA= 9,30			
with PFI mill											
Beating point	-	0	1	2	3			0	1	2	
PFI revolution	rpm	1450	1450	1450	1450				1450	1450	
	rev.								7000	11000	7462
	min								4,83	7,59	5,15
Freeness	SR							18	47	73	50
	CSF							633	248	72	224
Drainage time	s										
Grammage	g/m²								75,00	75,00	75,00
Thickness	mm										
Density	kg/m³								610	620	611
Bulk	m³/kg										
Stretch	%								2,81	2,67	2,79
Breaking length	m								6049	6185	6065
Burst strength	kPa								284	266	282
Tearing resistance	mN								575	570	575
MID double fold											
Tensile index	Nm/g								59,34	60,68	59,49
Burst index	kPam²/g								3,79	3,54	3,76
Tear index	mNm²/g								7,67	7,60	7,66
Bendtsen porosity	ml/min								1016	236	926
Bendtsen smoothness	ml/min										
Zero beaten pulp:											
Fibre length Arithmetic average	mm							1,13			
Fibre length weighted average	mm							1,60			
Coarseness	mg/m							0,095			
Slenderness factor								16,8			
Black liquor:											
pH		11,67									
Residual alkali as Na2O	g/l	2,60									
Dry solids content of org.liquor	%	13,7									
Organic content of dry solids	%	36,3									
Inorganic content of dry solids	%	63,7									
HHV of dry solids	kcal/kg	2469									
	kJ/kg	10337									
Specific gravity	g/cm³										

TABLE 31

Jute pulping **Kraft-AQ pulping at 150°C 12% AA, 4h**

Pilot plant: **Central Pulp and Paper Research Institute**
City: **Saharanpur**
Country: **India**
Conducted by:
Date: **26.4.1995**

TABLE 31A

	Unit	
Raw material		Jute
Quality of Fibre		
Size of fibre	mm	75
Pulping data		
Pulping Process		Kraft AQ
Cook No.		PP03
Type of digester		Pilot Plant
Size	m^3	11
Hydromodul		2,50
Raw material charge	kg	672
	kgBD	600
Dry content	%	89,29
NaOH Charge	%	12,39
Na2S Charge	%	3,02
Sulfidity	%	20,00
SO2 Charge	%	-
Na2SO3 Charge	%	-
Active Alkali charge as Na2O	%	12,00
Effective Alkali charge as Na2O	%	10,80
AQ charge	%	0,05
Heating up time	min	90
Cooking time	min	240
Cooking temp.	°C	150
H Factor	-	688
Kappa No.		11,60
Viscosity	ml/g	880
	cps	
Brightness	%	

9,30 tested at TTD

47,00
43,20

TABLE 31B

Physical properties:	Sample: from Cook No			PP03		KAPPA= 11,60		tested at TTD			
with PFI mill								KAPPA= 9,30			
Beating point	-	0	1	2	3			0	1	2	
PFI revolution	rpm								1450	1450	
	rev.								7000	11000	8120
	min								4,83	7,59	5,60
Freeness	SR								43	68	50
	CSF								284	100	224
Drainage time	s										
Grammage	g/m²								75,00	75,00	75,00
Thickness	mm										
Density	kg/m³								570	610	581
Bulk	m³/kg										
Stretch	%								2,99	2,95	2,98
Breaking length	m								6537	6511	6530
Burst strength	kPa								290	396	320
Tearing resistance	mN								726	689	716
MID double fold											
Tensile index	Nm/g								64,12	63,87	64,05
Burst index	kPam²/g								3,87	5,28	4,26
Tear index	mNm²/g								9,68	9,18	9,54
Bendtsen porosity	ml/min								1101	190	846
Bendtsen smoothness	ml/min										

Zero beaten pulp:			
Fibre length Arithmetic average	mm		1,19
Fibre length weighted average	mm		1,63
Fibre diameter	mm		
Coarseness	mg/m		0,104
Slenderness factor			15,7
Fibre zero span tensile	km		
fibre zero span strength index	Nm/g		
Black liquor:			
pH			
Residual alkali as Na2O	g/l	2,6?	
Viscosity at	RPM		
	mPa.S		
Dry solids content of org.liquor	%	13,7?	
Organic content of dry solids	%		
Inorganic content of dry solids	%		
HHV of dry solids	kcal/kg		
	kJ/kg		
Specific gravity	g/cm³		

TABLE 32

Jute pulping **Kraft-AQ pulping at 160°C 11,5% AA, 2h**

Pilot plant: **Central Pulp and Paper Research Institute**
City: **Saharanpur**
Country: **India**
Conducted by:
Date: **27.4.1995**

TABLE 32A

	Unit	
Raw material		Jute
Quality of Fibre		
Size of fibre	mm	75
Pulping data		
Pulping Process		Kraft AQ
Cook No.		PP04
Type of digester		Pilot Plant
Size	m^3	11
Hydromodul		2,50
Raw material charge	kg	448
	kgBD	400
Dry content	%	89,29
NaOH Charge	%	11,87
Na2S Charge	%	2,89
Sulfidity	%	20,00
SO2 Charge	%	-
Na2SO3 Charge	%	-
Active Alkali charge as Na2O	%	11,50
Effective Alkali charge as Na2O	%	10,35
AQ charge	%	0,05
Heating up time	min	90
Cooking time	min	120
Cooking temp.	°C	160
H Factor	-	1257
Kappa No.		14,10
Viscosity	ml/g	1010
	cps	
Brightness	%	

12,80 tested at TTD

78,00
41,80

TABLE 32B

Physical properties:		Sample: from Cook No KAPPA= 14,10		PP04	tested at TTD KAPPA= 12,80					
with PFI mill										
Beating point	-	0			0	1	2	3		
PFI revolution	rpm				1450	1450	1450	1450		
	rev.		2769	5263	0	4000	8000	12000	4667	9053
	min				0,00	2,76	5,52	8,28	3,22	6,24
Freeness	SR		30	50	18	27	45	64	30	50
	CSF		428	224	633	470	266	125	428	224
Drainage time	s									
Grammage	g/m²		60,00	60,00	75,00	75,00	75,00	75,00	75,00	75,00
Thickness	mm									
Density	kg/m³		610	680	410	540	590	630	548	601
Bulk	m³/kg									
Stretch	%		2,6	2,9	1,35	2,88	3,42	3,87	2,97	3,54
Breaking length	m		6524	7238	2723	6244	7279	7916	6417	7447
Burst strength	kPa		408	330	95	290	347	407	300	363
Tearing resistance	mN		660	696	825	991	894	848	975	882
MID double fold										
Tensile index	Nm/g		64,00	71,00	26,71	61,26	71,40	77,66	62,95	73,05
Burst index	kPam²/g		6,80	5,50	1,26	3,87	4,63	5,43	4,00	4,84
Tear index	mNm²/g		11,00	11,60	11,00	13,21	11,92	11,30	13,00	11,76
Bendtsen porosity	ml/min				3000	3000	629	177	2605	510
Bendtsen smoothness	ml/min									

Zero beaten pulp:		
Fibre length Arithmetic average	mm	1,24
Fibre length weighted average	mm	1,65
Fibre diameter	mm	
Coarseness	mg/m	0,125
Slenderness factor		13,2
Dirt cont acc. TAPPI	mm²/m²	168

Black liquor:		
pH		11,95
Residual alkali as Na2O	g/l	6,24
Dry solids content of org.liquor	%	11,62
Organic content of dry solids	%	33,7
Inorganic content of dry solids	%	66,3
HHV of dry solids	kcal/kg	2944
	kJ/kg	12324

TABLE 33

Physical properties of unbleached pulp produced in the pilot plant with Kraft-AQ pulping process prepared for bleaching tests

Messured at : **Pulp and Paper Institute, Ljubliana, Slowenia**

Sample from Pilot plant test No. PP04

		Good pulp sample					
with PFI mill							
Beating point	-	0	1	2	3		
PFI revolution	rpm	1450	1450	1450	1450		
	rev.	0	2120	6850	8880	3971	7720
	min	0,00	1,46	4,72	6,12	2,74	5,32
Freeness	SR	15	21	44	58	30	50
	CSF	706	571	275	164	428	224
Grammage	g/m²	79,30	75,95	74,84	74,20	75,52	74,57
Thickness	mm	0,174	0,142	0,124	0,118	0,135	0,121
Density	kg/m³	456	535	604	629	562	615
Bulk	m³/kg	2,193	1,869	1,656	1,590	1,786	1,628
Stretch	%	1,8	3,2	4,1	4,0	3,6	4,1
Breaking length	m	2752	6075	7818	7808	6757	7814
Burst strength	kPa	104	264	364	386	303	374
Tearing resistance	mN	1260	1233	919	922	1110	920
Tensile index	Nm/g	27,00	59,60	76,69	76,60	66,29	76,65
Burst index	kPam²/g	1,31	3,47	4,87	5,20	4,01	5,01
Tear index	mNm²/g	15,89	16,23	12,28	12,43	14,70	12,34
Zero beaten pulp:							
Fibre length Arithmetic average	mm	1,30					
Fibre length weighted average	mm	1,65					
Fibre diameter	mm						
Coarseness	mg/m	0,165					
Slenderness factor		10,0					
Fibre fraction Bauer McNett:							
retained on mesh 14	%	90,8					
retained on mesh 30	%	2,0					
retained on mesh 50	%	4,9					
retained on mesh 100	%	1,5					
going through mesh 100	%	0,8					
Viscosity	ml/g	988					

TABLE 34

Physical properties of unbleached pulp produced in the pilot plant with Kraft-AQ pulping process prepared for bleaching tests

Messured at : **Pulp and Paper Institute, Ljubliana, Slowenia**

Sample from Pilot plant test No. PP04

		Deteriated pulp sample					
with PFI mill							
Beating point	-	0	1	2	3		
PFI revolution	rpm	1450	1450	1450	1450		
	rev.	0	4350	7250	11600	6042	9860
	min	0,00	3,00	5,00	8,00	4,17	6,80
Freeness	SR	16	23	35	60	30	50
	CSF	680	535	366	151	428	224
Grammage	g/m²	73,45	75,45	71,97	73,56	73,42	72,92
Thickness	mm	0,183	0,137	0,119	0,158	0,127	0,142
Density	kg/m³	434	515	605	681	568	651
Bulk	m³/kg	2,304	1,810	1,530	1,468	1,647	1,493
Stretch	%	1,1	2,5	2,9	3,3	2,7	3,1
Breaking length	m	1497	3862	4525	4612	4249	4577
Burst strength	kPa	56	177	198	214	189	208
Tearing resistance	mN	838	871	643	562	738	594
Tensile index	Nm/g	14,69	37,89	44,39	45,24	41,68	44,90
Burst index	kPam²/g	0,76	2,35	2,75	2,91	2,58	2,85
Tear index	mNm²/g	11,41	11,54	8,93	7,64	10,05	8,15
Bendtsen porosity A/B side	ml/min				363	0	218
Bendtsen smoothness A/B side	ml/min		575	428	325	489	366
Scattering coefficient		237	216	217	214	217	215
Opacity	%	97,80	98,10	97,70	97,14	97,87	97,36
Zero beaten pulp:							
Fibre length Arithmetic average	mm	1,13					
Fibre length weighted average	mm	1,55					
Fibre diameter	mm						
Coarseness	mg/m	0,172					
Slenderness factor		9,0					
Fibre fraction Bauer McNett:							
retained on mesh 14	%	85,1					
retained on mesh 30	%	6,4					
retained on mesh 50	%	2,0					
retained on mesh 100	%	1,3					
going through mesh 100	%	5,4					
Viscosity	ml/g	669					

10.4 Bench scale bleaching tests

TABLE 40

Bleaching of kraft-AQ Jute pulp

Laboratory: Pulp and Paper Institute
City: Ljubliana
Country: Slovenia
Conducted by: IVA, Linz AUSTRIA , Dipl.Ing. Mohamed NAGA
Date: Mai-Jul 1995
Client: UNIDO, Vienna for Tribeni Mill

TABLE 40A

		TEST NUMBER						
	Unit	1	2	3	4	5	6	7*
Pulping process		Kraft-AQ	Kraft-AQ	Kraft-AQ	Kraft-AQ	Kraft-AQ	Kraft-AQ	Kraft-AQ
Kappa No. unbleached		10,2	10,2	10,2	10,2	10,2	10,2	9,6
Initial Brightness	% ISO							44,90
Viscosity	ml/g	1029	1029	1029	1029	1029	1029	1015
	cps							
Bleaching Sequence:		**C E H**	**C E H**	**C E H**	**C E H**	**C E H**	**C E H**	**C E H**
First Stage		**C**	**C**	**C**	**C**	**C**	**C**	**C**
HCl Charge	%							
Sulfamic acid	%	0,00	0,00	0,00	0,00	0,00	0,10	0,10
Chlorination factor		0,27	0,27	0,29	0,29	0,34	0,34	0,31
Active Chlorine applied	%	2,80	2,80	3,00	3,00	3,50	3,50	3,00
Residual Chlorine	%	1,05	0,24	0,43	0,06	0,14	0,49	0,83
Active Chlorine consumed	%	1,75	2,56	2,57	2,94	3,36	3,01	2,17
Temperature	°C	20	35	35	30	30	30	30
Retention time	min	30	30	45	45	45	45	45
Consistency	%	3,00	3,00	3,00	3,00	3,00	3,00	3,00
pH start			2,10	2,00	1,80	1,80	1,80	2,00
pH end		3,30	2,30	2,24	2,25	1,80	1,80	2,00
Kappa								1,20
Viscosity	ml/g							702
	cps							
Brightness	% ISO							60,70
Second Stage		**E**	**E**	**E**	**E**	**E**	**E**	**E**
NaOH	%	1,20	1,20	1,20	2,00	2,00	2,00	2,00
Temperature	°C	60	60	60	70	70	70	70
Retention time	min	90	90	90	90	120	120	120
Consistency	%	10,00	10,00	10,00	10,00	10,00	10,00	10,00
pH start		11,90	12,10	12,10	12,50	12,45	12,50	11,40
pH end		11,60	11,20	11,50	12,00	11,70	11,40	11,20
Kappa			1,60	1,70	1,10	1,00	< 1,0	0,90
Viscosity	ml/g		632	556	951	1008	998	646
	cps							
Brightness	% ISO		53,70	54,00	57,80	54,60	56,70	62,80

Third Stage		H	H	H	H	H	H	H
Sulfamic acid	%	0,00	0,00	0,00	0,10	0,10	0,10	0,10
Active Chlorine applied	%	1,00	1,00	1,50	1,00	1,30	1,30	1,30
Residual Chlorine	%	0,26	0,26	0,60	0,49	0,71	0,70	0,90
Active Chlorine consumed	%	0,74	0,74	0,90	0,51	0,59	0,60	0,40
NaOH as Buffer	%							
Temperature	°C	38	42	42	40	40	40	40
Retention time	min	180	180	210	120	180	180	150
Consistency	%	10,00	10,00	10,00	10,00	10,00	10,00	10,00
pH start			10,40	10,90	10,70	10,80	10,20	11,40
pH end		7,70	8,90	9,20	9,30	10,13	9,10	10,90
Total Active Chlorine applied	%	3,80	3,80	4,50	4,00	4,80	4,80	4,30
Total Active Chlorine consumed	%	2,49	3,30	3,47	3,45	3,95	3,61	2,57
Final Brightness absolute	% ISO	77,90	75,80	75,50	76,40	77,40	79,70	82,80
Final Brightness relative	%	79,90	77,80	77,50	78,40	79,40	81,70	84,80
Brigtness reversion	%						8,30	
Viscosity	ml/g	499	539	448	916	817	811	540
Classification of speks								
>5 mm²	speks/m²						0,0	
1,0-4,99 mm²	speks/m²						57,8	
0,4-0,99 mm²	speks/m²						101,0	
0,15-0,39 mm²	speks/m²						231,0	
Dirt cont acc. TAPPI	mm²/m²						305,68	
Fiber fraction Bauer McNett:								
retained on mesh 14	%						83,10	
retained on mesh 30	%						7,90	
retained on mesh 50	%						2,00	
retained on mesh 100	%						0,30	
going through mesh 100	%						6,70	

* Bleaching tests at ÖHFI, Vienna

TABLE 40B

		Sample: from test no.			6		
Physical properties:	**Unit**						
with PFI mill							
Beating point	-	0	1	2	3		
PFI revolution	rpm	1450	1450	1450	1450		
	rev.	0	5500	8008	11500	5500	10694
	min	0,00	3,79	5,52	7,93	3,79	7,38
Freeness	SR	15	30	40	53	30	50
	CSF	706	428	313	200	428	224
Drainage time	s						
Grammage	g/m²	76,03	75,32	75,00	74,92	75,32	74,94
Thickness	mm	0,170	0,130	0,121	0,113	0,130	0,115
Density	kg/m³	447	579	620	663	579	653
Bulk	m³/kg	2,237	1,727	1,612	1,508	1,727	1,532
Stretch	%	1,8	3,5	3,9	4,2	3,5	4,1
Breaking length	m	2456	5355	5705	6726	5355	6490
Burst strength	kPa	106,9	279,5	299,1	329,5	279,5	322,5
Tearing resistance	mN	1114	1123	912	949	1123	940
MID double fold		9	1212	1203	1047	1212	1083
Tensile index	Nm/g	24,09	52,53	55,97	65,98	52,53	63,67
Burst index	kPam²/g	1,41	3,70	3,99	4,40	3,71	4,30
Tear index	mNm²/g	14,65	14,91	12,16	12,67	14,91	12,55
Bendtsen porosity	ml/min			596,9	284,4	-	356,5
Bendtsen smoothness	ml/min	925,1	465,7	362,5	380,7	465,7	376,5
Scattering coefficient	m²/kg	24,6	24,1	24,9	24,9	24,1	24,9
Opacity	%	80,85	81,76	82,99	83,39	81,76	83,30

Zero beaten pulp:		1	2	average
Fibre length Arithmetic average	mm	1,220	1,230	1,225
Fibre length weighted average	mm	1,66	1,67	1,67
Fibre diameter	mm	0,030	0,030	0,030
Coarseness	mg/m	0,100	0,105	0,103
Slenderness factor		16,6	15,9	16,3
Fibre zero span tensile	km	8,34		
Fibre zero span strength index	Nm/g	81,8		

TABLE 40C

		Sample: from test no.			7*		
Physical properties:	**Unit**						
with PFI mill							
Beating point	-	0	1	2	3		
PFI revolution	rpm	0	1450	1450	1450		
	rev.	0	3500	7000	9000	3500	6300
	min	0,00	2,41	4,83	6,21	2,41	4,34
Freeness	SR	16	30	55	72	30	50
	CSF	680	428	185	78	428	224
Drainage time	s						
Grammage	g/m²	74,80	76,00	72,90	75,10	76,00	74,52
Thickness	mm	0,174	0,136	0,119	0,111	0,136	0,122
Density	kg/m³	430	560	610	680	560	600
Bulk	m³/kg	2,330	1,790	1,640	1,470	1,790	1,670
Stretch	%	1,69	3,05	3,37	3,45	3,05	3,31
Breaking length	m	2280	5240	6070	6240	5240	5904
Burst strength	kPa	86,2	255,7	293,7	298,2	255,7	286,1
Tearing resistance	mN	743	799	684	612	799	707
MID double fold		4	203	500	550	203	441
Tensile index	Nm/g	22,37	51,40	59,55	61,21	51,40	57,92
Burst index	kPam²/g	1,15	3,70	4,03	3,97	3,36	3,84
Tear index	mNm²/g	9,93	10,51	9,38	8,15	10,51	9,49
Bendtsen porosity	ml/min	3000	2950	400	230	2950	450
Bendtsen smoothness	ml/min	900	450	315	240	450	342
Scattering coefficient	m²/kg	26,22	29,14	29,38	30,01	29,14	29,33
Opacity	%	82,06	83,77	83,42	85,74	83,77	83,49
Zero beaten pulp:							
Fibre length Arithmetic average	mm	1,090					
Fibre length weighted average	mm	1,54					
Fibre diameter	*mm*						
Coarseness	mg/m	0,100					
Slenderness factor		15,4					
Fibre zero span tensile	km	16,00					
Fibre zero span strength index	Nm/g	157,0					

TABLE 41

Bleaching of kraft-AQ Jute pulp

Laboratory: Pulp and Paper Institute
City: Ljubliana
Country: Slovenia
Conducted by: IVA, Linz AUSTRIA , Dipl.Ing. Mohamed NAGA
Date: Mai-Jul 1995
Client: UNIDO, Vienna for Tribeni Mill

TABLE 41A

		TEST NUMBER				
	Unit	1	2	3	4	5*
Pulping process		Kraft-AQ	Kraft-AQ	Kraft-AQ	Kraft-AQ	Kraft-AQ
Kappa No. unbleached		10,2	10,2	10,2	10,2	9,6
Initial Brightness	% ISO					44,90
Viscosity	ml/g	1029	1029	1029	1029	1015
	cps					
Bleaching Sequence:		**C Ep H**	**C Ep H**	**C Ep H**	**C Ep H**	**C Ep H**
First Stage		**C**	**C**	**C**	**C**	**C**
HCl Charge	%					
Sulfamic acid	%	0,00	0,00	0,00	0,10	0,10
Chlorination factor		0,27	0,27	0,29	0,34	0,31
Active Chlorine applied	%	2,80	2,80	3,00	3,50	3,00
Residual Chlorine	%	0,99	0,29	0,52	0,68	0,66
Active Chlorine consumed	%	1,81	2,51	2,48	2,82	2,34
Temperature	°C	20	35	35	30	30
Retention time	min	30	30	45	45	45
Consistency	%	3,00	3,00	3,00	3,00	3,00
pH start		2,30	2,10	2,00	1,80	2,00
pH end		3,40	2,40	2,30	1,75	2,00
Kappa						1,20
Viscosity	ml/g					702
	cps					
Brightness	% ISO					60,70
Second Stage		**Ep**	**Ep**	**Ep**	**Ep**	**Ep**
NaOH	%	1,20	1,20	1,20	2,00	2,00
Peroxid applied	%	0,50	0,30	0,30	0,30	0,50
Residual peroxid	%	0,20	0,26	0,05	0,17	0,07
Peroxid consumed	%	0,30	0,04	0,25	0,13	0,43
Temperature	°C	60	60	70	70	70
Retention time	min	90	90	120	120	120
Consistency	%	10,00	10,00	10,00	10,00	10,00
pH start		11,50	12,00	12,20	12,44	11,30
pH end		11,40	11,70	11,60	12,04	11,10
Kappa			4,70	1,00	0,70	0,50
Viscosity	ml/g		974	504	897	610,00
	cps					
Brightness	% ISO		72,20	62,30	69,20	78,90

Third Stage		**H**	**H**	**H**	**H**	**H**
Sulfamic acid	%	0,00	0,00	0,00	0,10	0,10
Active Chlorine applied	%	1,00	0,70	0,70	1,30	1,30
Residual Chlorine	%	0,67	0,00	0,40	0,73	1,03
Active Chlorine consumed	%	0,33	0,70	0,30	0,57	0,27
NaOH as Buffer	%					
Temperature	°C	38	42	42	40	40
Retention time	min	180	180	180	180	180
Consistency	%	10,00	10,00	10,00	10,00	10,00
pH start		11,50	10,30	10,60	10,00	11,30
pH end		11,30	8,60	9,20	9,15	10,80
Total Active Chlorine applied	%	3,80	3,50	3,70	4,80	4,30
Total Active Chlorine consumed	%	2,14	3,21	2,78	3,39	2,61
Final Brightness absolute	% ISO	78,50	79,70	77,80	81,60	85,00
Final Brightness relative	%	80,50	81,70	79,80	83,60	87,20
Brigtness reversion	%				6,80	
Viscosity	ml/g	670	966	480	854	517
Classification of speks ISO						
>5 mm²	speks/m²				0,0	
1,0-4,99 mm²	speks/m²				43,0	
0,4-0,99 mm²	speks/m²				43,0	
0,15-0,39 mm²	speks/m²				535,0	
Dirt cont acc. TAPPI	mm²/m²				303,1	
Fiber fraction Bauer McNett:						
retained on mesh 14	%				81,70	
retained on mesh 30	%				7,70	
retained on mesh 50	%				1,90	
retained on mesh 100	%				0,70	
going through mesh 100	%				8,00	

* Bleaching tests at ÖHFI, Vienna

TABLE 41B

Sample: from test no. 4

Physical properties:	**Unit**						
with PFI mill							
Beating point	-	0	1	2	3		
PFI revolution	*rpm*	1450	1450	1450	1450		
	rev.	0	4980	8015	11900	5694	9715
	min	0,00	3,43	5,53	8,21	3,93	6,70
Freeness	SR	15	26	43	59	30	50
	CSF	706	485	284	157	428	224
Grammage	g/m²	75,16	75,95	77,23	76,35	76,25	76,85
Thickness	mm	0,161	0,131	0,123	0,112	0,129	0,118
Density	kg/m³	467	580	628	682	591	652
Bulk	m³/kg	2,141	1,724	1,592	1,466	1,693	1,537
Stretch	%	1,7	3,1	3,5	4,3	3,2	3,9
Breaking length	m	2212	5158	6035	7004	5364	6459
Burst strength	kPa	102,0	254,0	305,0	323,6	266,0	313,1
Tearing resistance	mN	1138	1085	1050	926	1077	996
MID double fold		7	829	1438	1046	972	1267
Tensile index	Nm/g	21,70	50,60	59,20	68,71	52,62	63,36
Burst index	kPam²/g	1,36	3,70	3,95	4,24	3,49	4,07
Tear index	mNm²/g	15,14	14,29	13,60	12,13	14,12	12,96
Bendtsen porosity	ml/min			493,75	156,25	-	346,09
Bendtsen smoothness	ml/min	918,75	568,75	493,75	312,50	551,10	414,45
Scattering coefficient	m²/kg	25,06	24,47	25,37	25,37	24,68	25,37
Opacity	%	80,67	80,98	83,53	84,19	81,58	83,82

Zero beaten pulp:		1	2	average
Fibre length Arithmetic average	mm	1,240	1,240	1,240
Fibre length weighted average	mm	1,65	1,66	1,66
Fibre diameter	mm	0,030	0,030	0,030
Coarseness	mg/m	0,106	0,106	0,106
Slenderness factor		15,6	15,7	15,6
Fibre zero span tensile	km	8,16		
fibre zero span strength index	Nm/g	80,0		

TABLE 41C

		Sample: from test no.			5*		
Physical properties:	**Unit**						
with PFI mill							
Beating point	-	0	1	2	3		
PFI revolution	rpm	0	1450	1450	1450		
	rev.	0	3500	7000	9000	3500	6192
	min	0,00	2,41	4,83	6,21	2,41	4,27
Freeness	SR	16	30	56	72	30	50
	CSF	680	428	178	78	428	224
Drainage time	s						
Grammage	g/m²	72,40	73,10	72,30	73,60	73,10	72,72
Thickness	mm	0,165	0,128	0,117	0,111	0,128	0,120
Density	kg/m³	440	570	620	660	570	608
Bulk	m³/kg	2,270	1,750	1,610	1,520	1,750	1,642
Stretch	%	1,64	3,04	3,49	3,15	3,04	3,39
Breaking length	m	2180	5090	5970	5800	5090	5767
Burst strength	kPa	79,5	245,2	278,1	292,3	245,2	270,5
Tearing resistance	mN	513	649	588	529	649	602
MID double fold		4	186	320	248	186	289
Tensile index	Nm/g	21,39	49,93	58,57	56,90	49,93	56,57
Burst index	kPam²/g	1,10	3,70	3,85	3,97	3,35	3,72
Tear index	mNm²/g	7,09	8,88	8,13	7,19	8,88	8,28
Bendtsen porosity	ml/min	3000	2730	400	220	2730	468
Bendtsen smoothness	ml/min	915	525	325	235	525	371
Scattering coefficient	m²/kg	22,4	27,4	29,6	29,0	27,4	29,11
Opacity	%	79,99	82,70	83,13	85,19	82,70	83,03
Zero beaten pulp:							
Fibre length Arithmetic average	mm	1,150					
Fibre length weighted average	mm	1,60					
Fibre diameter	mm						
Coarseness	mg/m	0,106					
Slenderness factor		15,1					
Fibre zero span tensile	km	16,20					
Fibre zero span strength index	Nm/g	158,9					

TABLE 42

Bleaching of kraft-AQ Jute pulp

Laboratory: **Pulp and Paper Institute**
City: ***Ljubliana***
Country: **Slovenia**
Conducted by: **IVA, Linz AUSTRIA , Dipl.Ing. Mohamed NAGA**
Date: **Mai-Jul 1995**
Client: **UNIDO, Vienna for Tribeni Mill**

TABLE 42A

		TEST NUMBER			
	Unit	1	2	3	4
Pulping process		Kraft-AQ	Kraft-AQ	Kraft-AQ	Kraft-AQ
Kappa No. unbleached		10,2	10,2	10,2	10,2
Initial Brightness	% ISO				
Viscosity	ml/g	1029	1029	1029	1029
	cps				
Bleaching Sequence:		**O C EO H**	**O C EO H**	**O C EO H**	**O C EO H**
First Stage		**O**	**O**	**O**	**O**
NaOH	%	1,50	1,50	1,50	2,00
MgSO4	%	0,50	0,50	0,50	0,10
Oxygen pressure	kg/cm²	4,00	4,00	6,00	6,00
Temperature	°C	90	90	95	95
Retention time	min	60	60	60	60
Consistency	%	10,00	10,00	10,00	10,00
pH start		12,00	12,10	12,20	12,40
pH end		10,90	11,00	10,50	10,90
Kappa		7,80	7,80	7,80	7,80
Viscosity	ml/g				
	cps				
Brightness	% ISO				
Second Stage		**C**	**C**	**C**	**C**
HCl Charge	%				
Sulfamic acid	%	0,00	0,00	0,00	0,10
Chlorination factor		0,20	0,20	0,21	0,25
Active Chlorine applied	%	1,56	1,56	1,64	1,95
Residual Chlorine	%	0,14	0,14	0,30	0,39
Active Chlorine consumed	%	1,42	1,42	1,34	1,56
Temperature	°C	20	35	35	30
Retention time	min	30	30	45	45
Consistency	%	3,00	3,00	3,00	3,00
pH start		2,00	2,10	2,10	1,80
pH end		2,10	2,40	2,50	1,80
Kappa					
Viscosity	ml/g				
	cps				
Brightness	% ISO				

Third Stage		**E/O**	**E/O**	**E/O**	**E/O**
NaOH	%	1,00	1,00	1,00	1,50
Oxygen pressure	kg/cm²	2,50	2,50	2,50	2,50
Temperature	°C	90	70	60	70
Retention time	min	60	90	60	60
Consistency	%	10,00	10,00	10,00	10,00
pH start		12,10	12,00	12,10	12,20
pH end		10,30	11,00	10,70	11,20
Kappa			0,70		0,34
Viscosity	ml/g		591		903
	cps				
Brightness	% ISO		68,90	68,00	73,20
Forth Stage		**H**	**H**	**H**	**H**
Sulfamic acid	%				0,10
Active Chlorine applied	%	1,00	0,70	1,50	1,00
Residual Chlorine	%	0,73	0,28	0,81	0,51
Active Chlorine consumed	%	0,27	0,42	0,69	0,49
NaOH as Buffer	%				
Temperature	°C	40	42	42	40
Retention time	*min*	180	180	210	180
Consistency	%	10,00	10,00	10,00	10,00
pH start		10,10	10,40	10,70	9,90
pH end		8,90	8,90	9,50	8,90
Total Active Chlorine applied	%	2,56	2,26	3,14	2,95
Total Active Chlorine consumed	%	1,69	1,84	2,03	2,05
Final Brightness absolute	% ISO	80,50	79,00	79,10	83,00
Final Brightness relative	%	82,50	81,00	81,10	85,00
Brigtness reversion	%				4,30
Viscosity	ml/g	756	583	473	792
Classification of speks ISO					
>5 mm²	speks/m²				0,0
1,0-4,99 mm²	speks/m²				72,0
0,4-0,99 mm²	speks/m²				43,0
0,15-0,39 mm²	speks/m²				376,0
Dirt cont acc. TAPPI	mm²/m²				347,0
Fiber fraction Bauer McNett:					
retained on mesh 14	%				92,40
retained on mesh 30	%				4,40
retained on mesh 50	%				1,40
retained on mesh 100	%				0,20
going through mesh 100	%				1,60

TABLE 42B

		Sample: from test no.			4		
Physical properties:	**Unit**						
with PFI mill							
Beating point	-	0	1	2	3		
PFI revolution	rpm	1450	1450	1450	1450		
	rev.	0	5000	7960	11470	6184	11470
	min	0,00	3,45	5,49	7,91	4,26	7,91
Freeness	SR	16	24	39	50	30	50
	CSF	680	517	323	224	428	224
Grammage	g/m²	77,62	76,75	76,19	76,19	76,53	76,19
Thickness	mm	0,176	0,136	0,122	0,117	0,130	0,117
Density	kg/m³	441	564	625	651	588	651
Bulk	m³/kg	2,267	1,773	1,600	1,536	1,704	1,536
Stretch	%	1,6	3,3	3,9	4,0	3,5	4,0
Breaking length	m	2028	5083	5613	5963	5295	5963
Burst strength	kPa	82,4	247,1	300,5	312,8	268,5	312,8
Tearing resistance	mN	960	1070	956	900	1024	900
MID double fold		4	447	1390	1392	824	1392
Tensile index	Nm/g	19,89	49,86	55,06	58,50	51,94	58,50
Burst index	kPam²/g	1,06	3,70	3,94	4,11	3,51	4,11
Tear index	mNm²/g	12,37	13,94	12,55	11,81	13,39	11,81
Bendtsen porosity	ml/min			715,65	281,30	3000	281,30
Bendtsen smoothness	ml/min	956,25	478,15	387,50	362,50	441,89	362,50
Scattering coefficient	m²/kg	26,10	24,74	25,20	25,41	24,92	25,41
Opacity	%	80,44	80,31	82,12	82,76	81,03	82,76
Zero beaten pulp:		1	2	3	average		
Fibre length Arithmetic average	mm	1,210	1,210	1,210	1,210		
Fibre length weighted average	mm	1,62	1,62	1,63	1,62		
Fibre diameter	mm	0,030	0,030	0,030	0,030		
Coarseness	mg/m	0,144	0,146	0,149	0,146		
Slenderness factor		11,3	11,1	10,9	11,1		
Fibre zero span tensile	km	5,21					
fibre zero span strength index	Nm/g	51,1					

TABLE 43

Bleaching of kraft-AQ Jute pulp

Laboratory: Pulp and Paper Institute
City: Ljubliana
Country: Slovenia
Conducted by: IVA, Linz AUSTRIA , Dipl.Ing. Mohamed NAGA
Date: Mai-Jul 1995
Client: UNIDO, Vienna for Tribeni Mill

TABLE 43A

		TEST NUMBER						
	Unit	1	2**	3	4	5	6*	7*
Pulping process		Kraft-AQ	Kraft-AQ	Kraft-AQ	Kraft-AQ	Kraft-AQ	Kraft-AQ	Kraft-AQ
Kappa No. unbleached		10,2	10,2	10,2	10,2	10,2	9,6	9,6
Initial Brightness	% ISO						44,90	44,90
Viscosity	ml/g	1029	1029	1029	1029	1029	1015	1015
Bleaching Sequence:		**D E D**	**D E D**	**D E D**	**D E D**	**D E D**	**D E D**	**D E D**
First Stage		**D0**	**D0**	**D0**	**D0**	**D0**	**D0**	**D0**
HCl Charge	%							
Sulfamic acid	%	0,00	0,00	0,00	0,10	0,10	0,00	0,00
Chlorination factor		0,27	0,27	0,34	0,25	0,25	0,31	0,31
Active Chlorine applied	%	2,80	2,80	3,50	2,55	2,55	3,00	3,00
Residual Chlorine	%	0,22	0,27	1,74	0,70	0,93	0,01	0,01
Active Chlorine consumed	%	2,58	2,53	1,76	1,85	1,62	2,99	2,99
Temperature	°C	65	60	60	60	60	60	60
Retention time	min	35	35	60	60	60	60	60
Consistency	%	10,00	10,00	10,00	10,00	10,00	10,00	10,00
pH start				2,00	2,00	3,50	3,00	3,20
pH end		2,10	6,50	2,36	2,15	2,82	2,60	2,40
Kappa							3,40	3,20
Viscosity	ml/g						1013	1010
	cps							
Brightness	% ISO						68,80	70,70
Second Stage		**E**	**E**	**E**	**E**	**E**	**E**	**E**
NaOH	%	1,20	1,20	1,20	2,00	2,00	2,00	2,00
Temperature	°C	60	90	60	70	70	70	70
Retention time	min	90	60	90	120	120	120	120
Consistency	%	10,00	10,00	10,00	10,00	10,00	10,00	10,00
pH start		12,30	12,10	12,10	12,30	12,25	11,60	11,30
pH end		11,90	11,80	11,80	11,50	11,90	11,30	11,00
Kappa				4,80			3,20	2,90
Viscosity	ml/g			972	973	961	989	982
	cps							
Brightness	% ISO		59,80	63,50	69,00	70,30	70,80	71,80

Third Stage		**D1**	**D1**	**D1**	**D1**	**D1**	**D1**	**D1**
Sulfamic acid	%	0,00	0,00	0,00	0,10	0,10	0,00	0,00
Active Chlorine applied	%	1,00	1,00	1,50	2,00	2,00	5,30	2,50
Residual Chlorine	%	0,16	0,12	0,24	0,03	0,30	0,09	0,08
Active Chlorine consumed	%	0,84	0,88	1,26	1,97	1,70	5,21	2,42
NaOH as Buffer	%							
Temperature	°C	70	70	70	75	75	70	70
Retention time	min	150	180	210	210	210	180	180
Consistency	%	10,00	10,00	10,00	10,00	10,00	10,00	10,00
pH start		3,00		3,40	3,78	3,80	4,30	6,00
pH end		3,30	7,20	3,90	2,33	2,60	2,60	3,80
Total Active Chlorine applied	%	3,80	3,80	5,00	4,55	4,55	8,30	5,50
Total Active Chlorine consumed	%	3,42	3,41	3,02	3,82	3,32	8,20	5,41
Final Brightness absolute	% ISO	77,60	73,30	77,20	78,80	78,00	83,50	85,80
Final Brightness relative	%	79,60	75,30	79,20	80,80	80,00	85,80	87,00
Brigtness reversion	%							
Viscosity	ml/g	962	642	973	941	936	935	937
Fourth Stage					**D2**			
Sulfamic acid	%				0,10			
Active Chlorine applied	%				1,00			
Residual Chlorine	%				0,53			
Active Chlorine consumed	%				0,47			
NaOH as Buffer	%							
Temperature	°C				75			
Retention time	min				150			
Consistency	%				10,00			
pH start					3,70			
pH end					3,56			
Total Active Chlorine applied	%				5,55			
Total Active Chlorine consumed	%				4,29			
Final Brightness absolute	% ISO				81,70			
Final Brightness relative	%				83,70			
Brigtness revertion	%				3,30			
Viscosity	ml/g				925			
Classification of speks ISO								
>5 mm²	speks/m²				0,0			
1,0-4,99 mm²	speks/m²				32,0			
0,4-0,99 mm²	speks/m²				127,0			
0,15-0,39 mm²	speks/m²				382,0			
Dirt cont acc. TAPPI	mm²/m²				287,2			
Fiber fraction Bauer McNett:								
retained on mesh 14	%				87,50			
retained on mesh 30	%				4,40			
retained on mesh 50	%				2,40			
retained on mesh 100	%				0,10			
going through mesh 100	%				5,60			

* Bleaching tests at ÖHFI, Vienna

TABLE 43B

Sample: from test no. 4

Physical properties:	**Unit**						
with PFI mill							
Beating point	-	0	1	2	3		
PFI revolution	rpm	1450	1450	1450	1450		
	rev.	0	5400	8000	11300	6050	11300
	min	0,00	3,72	5,52	7,79	4,17	7,79
Freeness	SR	14	27	39	50	30	50
	CSF	733	470	323	224	428	224
Grammage	g/m²	73,96	73,96	74,52	73,88	74,10	73,88
Thickness	mm	0,165	0,125	0,118	0,114	0,123	0,114
Density	kg/m³	448,2	591,6	631,5	648,1	601,6	648,1
Bulk	m³/kg	2,231	1,690	1,583	1,543	1,663	1,543
Stretch	%	1,5	3,3	4,0	4,0	3,5	4,0
Breaking length	m	2100	5142	6523	6688	5487	6688
Burst strength	kPa	74,5	277,5	312,8	319,7	286,3	319,7
Tearing resistance	mN	790	1172	1066	990	1146	990
MID double fold		3	1223	1279	1463	1237	1463
Tensile index	Nm/g	20,60	50,44	63,99	65,61	53,83	65,61
Burst index	kPam²/g	1,01	3,70	4,20	4,33	3,86	4,33
Tear index	mNm²/g	10,68	15,85	14,30	13,40	15,46	13,40
Bendtsen porosity	ml/min			638	400	-	400
Bendtsen smoothness	ml/min	918,50	488,00	406,50	350,00	467,63	350,00
Scattering coefficient	m²/kg	23,26	23,86	24,28	24,45	23,96	24,45
Opacity	%	78,88	81,30	82,08	82,54	81,49	82,54
Zero beaten pulp:		1	2	average			
Fibre length Arithmetic average	mm	1,190	1,200	1,195			
Fibre length weighted average	mm	1,60	1,63	1,615			
Fibre diameter	mm	0,030	0,030	0,030			
Coarseness	mg/m	0,110	0,108	0,109			
Slenderness factor		14,5	15,1	14,8			
Fibre zero span tensile	km	6,36					
fibre zero span strength index	Nm/g	62,4					

* Bleaching tests at ÖHFI, Vienna

TABLE 43C

		Sample: from test no.			7*			
Physical properties:	**Unit**							
with PFI mill								
Beating point	-	0	1	2	3	4		
PFI revolution	rpm	0	1450	1450	1450	1450		
	rev.	0	3500	7500	12000	14500	4731	9750
	min	0,00	2,41	5,17	8,28	10,00	3,26	6,72
Freeness	SR	16	26	39	61	71	30	50
	CSF	680	485	323	144	83	428	224
Drainage time	s							
Grammage	g/m²	71,80	72,00	72,00	71,70	72,30	72,00	71,85
Thickness	mm	0,163	0,129	0,118	0,112	0,108	0,126	0,115
Density	kg/m³	440	560	610	640	670	575	625
Bulk	m³/kg	2,270	1,790	1,640	1,560	1,490	1,744	1,600
Stretch	%	1,87	3,01	3,31	3,67	3,84	3,10	3,49
Breaking length	m	2130	4850	6320	6660	7000	5302	6490
Burst strength	kPa	81,05	244,96	326,40	343,61	356,30	270,02	335,01
Tearing resistance	mN	868	1071	883	864	795	1013	874
MID double fold		4	237	1317	1046	1502	569	1182
Tensile index	Nm/g	20,90	47,58	62,00	65,33	68,67	52,02	63,67
Burst index	kPam²/g	1,13	3,70	4,53	4,79	4,93	3,75	4,66
Tear index	mNm²/g	12,09	14,88	12,26	12,05	11,00	14,07	12,16
Bendtsen porosity	ml/min	3000	3000	1320	305	160	2483	465
Bendtsen smoothness	ml/min	920	475	390	300	270	449	345
Scattering coefficient	m²/kg	24,08	23,46	27,55	29,97	29,16	24,72	28,76
Opacity	%	80,57	79,18	81,78	83,87	85,35	79,98	82,83
Zero beaten pulp:								
Fibre length Arithmetic average	mm	1,100						
Fibre length weighted average	mm	1,56						
Fibre diameter	mm							
Coarseness	mg/m	0,106						
Slenderness factor		14,72						
Fibre zero span tensile	km	17,00						
Fibre zero span strength index	Nm/g	166,8						

TABLE 44

Bleaching of kraft-AQ Jute pulp

Laboratory: **Pulp and Paper Institute**
City: **Ljubliana**
Country: **Slovenia**
Conducted by: **IVA, Linz AUSTRIA , Dipl.Ing. Mohamed NAGA**
Date: **Mai-Jul 1995**
Client: **UNIDO, Vienna for Tribeni Mill**

TABLE 44A

		TEST NUMBER		
	Unit	1	2	3
Pulping process		Kraft-AQ	Kraft-AQ	Kraft-AQ
Kappa No. unbleached		10,2	10,2	10,2
Initial Brightness	% ISO			
Viscosity	ml/g	1029	1029	1029
Bleaching Sequence:		**O D EO D**	**O D EO D**	**O D EO D**
First Stage		**O**	**O**	**O**
NaOH	%	1,50	1,50	2,00
MgSO4	%	0,50	0,50	0,10
Oxygen pressure	kg/cm²			6,00
Temperature	°C	90	90	95
Retention time	min	60	60	60
Consistency	%	10,00	10,00	10,00
pH start		12,00	11,90	12,40
pH end		10,60	10,60	11,00
Kappa		7,80	7,80	7,50
Viscosity	ml/g	953,00		
	cps			
Brightness	% ISO			
Second Stage		**D0**	**D0**	**D0**
HCl Charge	%			
Sulfamic acid	%	0,00	0,00	0,10
Chlorination factor		0,20	0,20	0,26
Active Chlorine applied	%	1,56	1,56	1,95
Residual Chlorine	%	0,48	0,38	0,73
Active Chlorine consumed	%	1,08	1,18	1,22
Temperature	°C	65	60	60
Retention time	min	60	60	60
Consistency	%	10,00	10,00	10,00
pH start		2,00	2,00	2,00
pH end		3,20	3,10	2,18
Kappa				
Viscosity	ml/g			
	cps			
Brightness	% ISO			
Third Stage		**E/O**	**E/O**	**E/O**
NaOH	%	1,00	1,00	1,50
Oxygen pressure	kg/cm²	2,50	2,50	2,50
Temperature	°C	90	70	70
Retention time	min	60	90	60
Consistency	%	10,00	10,00	10,00

pH start		12,00	11,90	12,30
pH end		10,60	10,70	11,40
Kappa			3,30	5,20
Viscosity	ml/g		616,00	915,00
	cps			
Brightness	% ISO	66,00	68,00	74,30
Forth Stage		**D1**	**D1**	**D1**
Sulfamic acid	%			0,10
Active Chlorine applied	%	1,00	2,00	2,00
Residual Chlorine	%	0,10	0,13	0,00
Active Chlorine consumed	%	0,90	1,87	2,00
NaOH as Buffer	%			
Temperature	°C	70		75
Retention time	min	150		210
Consistency	%	10,00		10,00
pH start		4,00		4,03
pH end		4,10		2,40
Total Active Chlorine applied	%	2,56	3,56	3,95
Total Active Chlorine consumed	%	1,98	3,05	3,22
Final Brightness absolute	% ISO	78,30	77,50	82,40
Final Brightness relative	%	80,30	79,50	84,40
Brigtness reversion	%			
Viscosity	ml/g	924		821
	cps			
Fourth Stage				**D2**
Sulfamic acid	%			0,10
Active Chlorine applied	%			1,00
Residual Chlorine	%			0,50
Active Chlorine consumed	%			0,50
NaOH as Buffer	%			
Temperature	°C			75
Retention time	min			150
Consistency	%			10,00
pH start				3,80
pH end				3,70
Total Active Chlorine applied	%			4,95
Total Active Chlorine consumed	%			3,72
Final Brightness absolute	% ISO			82,70
Final Brightness relative	%			84,70
Brigtness revertion	%			6,50
Viscosity	ml/g			811
Classification of speks ISO				
>5 mm²	speks/m²			0,0
1,0-4,99 mm²	speks/m²			48,0
0,4-0,99 mm²	speks/m²			96,0
0,15-0,39 mm²	speks/m²			303,0
Dirt cont acc. TAPPI	mm²/m²			292,3
Fiber fraction Bauer McNett:				
retained on mesh 14	%			91,70
retained on mesh 30	%			5,20
retained on mesh 50	%			0,80
retained on mesh 100	%			0,20
going through mesh 100	%			2,10

TABLE 44B

		Sample: from test no.			3		
Physical properties:	**Unit**						
with PFI mill							
Beating point	-	0	1	2	3		
PFI revolution	rpm	1450	1450	1450	1450		
	rev.	0	4900	6680	9500	5968	9688
	min	0,00	3,38	4,61	6,55	4,12	6,68
Freeness	SR	15	24	34	49	30	50
	CSF	706	517	378	232	428	224
Grammage	g/m²	74,60	76,11	76,03	68,79	76,06	68,31
Thickness	mm	0,166	0,132	0,123	0,106	0,127	0,105
Density	kg/m³	449	577	618	649	602	651
Bulk	m³/kg	2,227	1,733	1,618	1,541	1,664	1,536
Stretch	%	1,5	3,4	3,7	3,9	3,6	3,9
Breaking length	m	1917	5300	5994	6597	5716	6637
Burst strength	kPa	81,4	253,7	305,2	319,5	284,6	320,5
Tearing resistance	mN	776	1267	1051	825	1137	810
MID double fold		3	933	1053	1093	1005	1096
Tensile index	Nm/g	18,81	51,99	58,80	64,72	56,08	65,11
Burst index	kPam²/g	1,09	3,70	4,01	4,64	3,74	4,69
Tear index	mNm²/g	10,40	16,65	13,82	11,99	14,95	11,86
Bendtsen porosity	ml/min			944	338	3000	298
Bendtsen smoothness	ml/min	866,00	600,50	431,50	313,00	499,10	305,10
Scattering coefficient	m²/kg	24,03	24,54	25,01	22,11	24,82	21,91
Opacity	%	78,56	80,43	81,74	80,23	81,21	80,12
Zero beaten pulp:		1	2	average			
Fibre length Arithmetic average	mm	1,200	1,200	1,200			
Fibre length weighted average	mm	1,62	1,60	1,610			
Fibre diameter	mm						
Coarseness	mg/m	0,121	0,125	0,123			
Slenderness factor		13,4	12,8	13,1			
Fibre zero span tensile	km	5,97					
fibre zero span strength index	Nm/g	58,6					

TABLE 45

Bleaching of kraft-AQ Jute pulp

Laboratory: Pulp and Paper Institute
City: Ljubliana / Vienna*
Country: Slovenia / AUSTRIA*
Conducted by: IVA, Linz AUSTRIA , Dipl.Ing. Mohamed NAGA
Date: Mai-Jul 1995
Client: UNIDO, Vienna for Tribeni Mill

TABLE 45A

		TEST NUMBER		
	Unit	1	2*	3
Pulping process		Kraft-AQ	Kraft-AQ	Kraft-AQ
Kappa No. unbleached		10,2	9,6	10,2
Initial Brightness	% ISO		44,90	
Viscosity	ml/g	1029	1015	1029
	cps			
Bleaching Sequence:		**O A EOP P**	**O A EOP P**	**O Q EOP P**
First Stage		**O**	**O**	**O**
NaOH	%	1,50	1,50	1,50
MgSO4	%	0,50	0,50	0,10
Oxygen pressure	kg/cm²	6,00	6,00	6,00
Temperature	°C	95	95	95
Retention time	min	60	60	60
Consistency	%	10,00	10,00	10,00
pH start		11,90	11,10	12,40
pH end		10,80	11,40	11,60
Kappa		7,80	6,60	7,50
Viscosity	ml/g	953	944	
	cps			
Brightness	% ISO		56,60	
Second Stage		**A**	**A**	**Q**
HCl Charge	%			
DTPA	%	0,00		0,20
H2SO4	%			
Temperature	°C	70	70	70
Retention time	min	60	60	60
Consistency	%	10,00	10,00	10,00
pH start		2,00	2,00	5-5,5
pH end		2,20	2,20	5,32
Kappa				
Viscosity	ml/g			
	cps			
Brightness	% ISO		58,70	

Third Stage		**EOP**	**EOP**	**EOP**
NaOH	%	2,00	1,50	1,00
Peroxid applied	%	3,00	3,00	2,00
Residual peroxid	%	0,00	0,01	0,21
Peroxid consumed	%	3,00	2,99	1,79
DTPA	%		0,20	0,20
EDTA	%	0,03		
MgSO4	%	0,05	0,20	0,20
H2SO4	%			
Oxygen pressure	kg/cm²	4,00	4,00	4,00
Temperature	°C	95	85	85
Retention time	min	15/150	15/150	15/150
Consistency	%	10,00	10,00	10,00
pH start		11,30	10,90	11,04
pH end		11,10	10,80	10,99
Kappa		3,00	5,10	6,60
Viscosity	ml/g	389	562	875
	cps			
Brightness	% ISO	69,10	79,20	72,30
Forth Stage		**P**	**P**	**P**
NaOH	%	1,00	0,50	1,00
Peroxid applied	%	1,00	1,00	2,00
Residual peroxid	%	0,65	0,02	1,04
Peroxid consumed	%	0,35	0,98	0,96
DTPA	%		0,20	0,20
EDTA	%	0,03		
MgSO4	%	0,05	0,20	0,20
H2SO4	%			
Oxygen pressure	kg/cm²			
Temperature	°C	90	90	90
Retention time	min	180	180	180
Consistency	%	10,00	10,00	10,00
pH start		11,60	9,80	11,50
pH end		11,20	10,10	11,40
Final Brightness absolute	% ISO	78,20	82,70	75,90
Final Brightness relative	%	80,20	84,70	77,90
Brigtness reversion	%			7,40
Viscosity	ml/g	386	550	869
Classification of speks ISO				
>5 mm²	speks/m²			0,0
1,0-4,99 mm²	speks/m²			0,0
0,4-0,99 mm²	speks/m²			87,0
0,15-0,39 mm²	speks/m²			361,0
Dirt cont acc. TAPPI	mm²/m²			157,9
Fiber fraction Bauer McNett:				
retained on mesh 14	%			90,80
retained on mesh 30	%			4,10
retained on mesh 50	%			1,10
retained on mesh 100	%			0,90
going through mesh 100	%			3,10

* Bleaching tests at ÖHFI, Vienna

TABLE 45B

		Sample: from test no.			3		
Physical properties:	**Unit**						
with PFI mill							
Beating point	-	0	1	2	3		
PFI revolution	rpm	1450	1450	1450	1450		
	rev.	0	5440	8080	12060	5440	9141
	min	0,00	3,75	5,57	8,32	3,75	6,30
Freeness	SR	15	30	46	61	30	50
	CSF	706	428	257	144	428	224
Grammage	g/m²	72,21	75,24	75,48	76,27	75,24	75,69
Thickness	mm	0,159	0,122	0,117	0,111	0,122	0,115
Density	kg/m³	454	616	645	687	616	656
Bulk	m³/kg	2,202	1,623	1,550	1,455	1,623	1,525
Stretch	%	1,6	3,7	4,0	4,4	3,7	4,1
Breaking length	m	1929	6428	6687	7584	6428	6926
Burst strength	kPa	69,60	322,60	326,50	356,00	322,60	334,37
Tearing resistance	mN	692	994	886	880	994	884
MID double fold		3	1801	1834	1655	1801	1786
Tensile index	Nm/g	18,92	63,06	65,60	74,40	63,06	67,95
Burst index	kPam²/g	0,96	4,29	4,33	4,67	4,29	4,42
Tear index	mNm²/g	9,58	13,21	11,74	11,54	13,21	11,68
Bendtsen porosity	ml/min			368,8	118,8	3000	302,1
Bendtsen smoothness	ml/min	956,30	409,41	396,90	281,30	409,41	366,07
Scattering coefficient	m²/kg	23,01	22,92	23,12	22,61	22,92	22,99
Opacity	%	81,54	81,91	82,66	82,82	81,91	82,70
Zero beaten pulp:		1	2	3	average		
Fibre length Arithmetic average	mm	1,210	1,220	1,230	1,220		
Fibre length weighted average	mm	1,63	1,65	1,66	1,647		
Fibre diameter	mm						
Coarseness	mg/m	0,120	0,113	0,116	0,116		
Slenderness factor		13,6	14,6	14,3	14,2		
Fibre zero span tensile	km	6,50					
fibre zero span strength index	Nm/g	63,8					

TABLE 46

Bleaching of kraft-AQ Jute pulp

Laboratory: Pulp and Paper Institute
City: Ljubliana / Vienna*
Country: Slovenia / AUSTRIA*
Conducted by: IVA, Linz AUSTRIA , Dipl.Ing. Mohamed NAGA
Date: Mai-Jul 1995
Client: UNIDO, Vienna for Tribeni Mill

TABLE 46A

		TEST NUMBER		
	Unit	1	2*	3*
Pulping process		Kraft-AQ	Kraft-AQ	Kraft-AQ
Kappa No. unbleached		10,2	9,6	9,6
Initial Brightness	% ISO		44,90	44,90
Viscosity	ml/g	1029	1015	1015
	cps			
Bleaching Sequence:		**O A Z P**	**O A Z P**	**O Q Z P**
First Stage		**O**	**O**	**O**
NaOH	%	1,50	1,50	1,50
MgSO4	%	0,50	0,50	0,50
Oxygen pressure	kg/cm²	6,00	6,00	6,00
Temperature	°C	95	95	95
Retention time	min	60	60	60
Consistency	%	10,00	10,00	10,00
pH start		12,00	11,20	11,20
pH end		10,50	11,00	11,00
Kappa		7,40	7,30	7,20
Viscosity	ml/g	953	936	932
	cps			
Brightness	% ISO		58,10	58,10
Second Stage		**A**	**A**	**Q**
HCl Charge	%			
NaOH	%			
EDTA	%			0,50
MgSO4	%			
H2SO4	%			
Temperature	°C	70	70	70
Retention time	min	60	60	60
Consistency	%	10,00	10,00	10,00
pH start		2,00	2,00	5,20
pH end		2,20	2,00	5,40
Kappa		6,80		6,50
Viscosity	ml/g	929		968
	cps			
Brightness	% ISO	55,80	60,80	61,60

Third Stage		**Z**	**Z**	**Z**
HCl Charge	%			
NaOH	%			
O3 applied	%	0,50	0,61	0,88
O3 Residual	%		0,23	0,33
O3 consumed	%		0,38	0,55
DTPA	%			
MgSO4	%			
H2SO4	%			
Temperature	°C	40	50	50
Retention time	min	5	5	
Consistency	%	20,00	10,00	10,00
pH start			2,00	2,00
pH end			2,00	2,00
Kappa		5,30	0,70	0,50
Viscosity	ml/g	883,00	683,00	658,00
	cps			
Brightness	% ISO	59,20	75,50	76,50
Forth Stage		**P**	**P**	**P**
NaOH	%	1,50	1,50	1,50
Peroxid applied	%	2,50	3,00	3,00
Residual peroxid	%	1,36	1,36	0,01
Peroxid consumed	%	1,14	1,64	2,99
DTPA	%	0,03	0,20	0,20
MgSO4	%	0,05	0,20	0,20
H2SO4	%			
Temperature	°C	90	90	90
Retention time	min	180	180	180
Consistency	%	10,00	10,00	10,00
pH start		10,90	10,10	10,60
pH end		10,40	10,60	10,70
Final Brightness absolute	% ISO	76,10	84,80	87,30
Final Brightness relative	%	78,10	86,80	89,30
Brigtness reversion	%			
Viscosity	ml/g	800	584	525
Classification of speks ISO				
>5 mm²	speks/m²			
1,0-4,99 mm²	speks/m²			
0,4-0,99 mm²	speks/m²			
0,15-0,39 mm²	speks/m²			
Dirt cont acc. TAPPI	mm²/m²			
Fiber fraction Bauer McNett:				
retained on mesh 14	%			
retained on mesh 30	%			
retained on mesh 50	%			
retained on mesh 100	%			
going through mesh 100	%			

* Bleaching tests at ÖHFI, Vienna

TABLE 46B

		Sample: from test no.			3*			
Physical properties:	**Unit**							
with PFI mill								
Beating point	-	0	1	2	3	4		
PFI revolution	rpm	1450	1450	1450	1450	1450		
	rev.	0	4000	6000	8000	12000	2750	6235
	min	0,00	2,76	4,14	5,52	8,28	1,90	4,30
Freeness	SR	19	35	48	65	81	30	50
	CSF	611	366	240	119	30	428	224
Grammage	g/m²	73,60	75,10	73,20	74,90	73,50	74,63	73,40
Thickness	mm	0,171	0,136	0,128	0,123	0,122	0,147	0,127
Density	kg/m³	430	550	570	610	600	513	575
Bulk	m³/kg	2,320	1,810	1,750	1,640	1,660	1,969	1,737
Stretch	%	2,91	3,85	3,57	3,65	3,88	3,56	3,58
Breaking length	m	1543	4753	5405	5923	6153	3750	5466
Burst strength	kPa	74,96	256,48	302,57	329,24	329,76	199,76	305,71
Tearing resistance	mN	549	1052	811	784	647	895	808
MID double fold		52	268	440	792	477	201	481
Tensile index	Nm/g	15,14	46,63	53,02	58,10	60,36	36,79	53,62
Burst index	kPam²/g	1,02	3,42	4,13	4,40	4,49	2,68	4,16
Tear index	mNm²/g	7,46	14,01	11,08	10,47	8,80	11,99	11,01
Bendtsen porosity	ml/min	3581	2954	1391	333	116	3149,9	429
Bendtsen smoothness	ml/min	1158	453	423	439	422	453	425
Scattering coefficient	m²/kg	22,5	26,8	28,4	29,7	31,7	26,2	28,6
Opacity	%	77,4	82,0	82,7	83,7	85,6	81,7	82,8
Zero beaten pulp:								
Fibre length Arithmetic average	mm	1,020						
Fibre length weighted average	mm	1,41						
Fibre diameter	mm							
Coarseness	mg/m	0,109						
Slenderness factor		12,9						
Fibre zero span tensile	km							
fibre zero span strength index	Nm/g	0,0						

TABLE 47

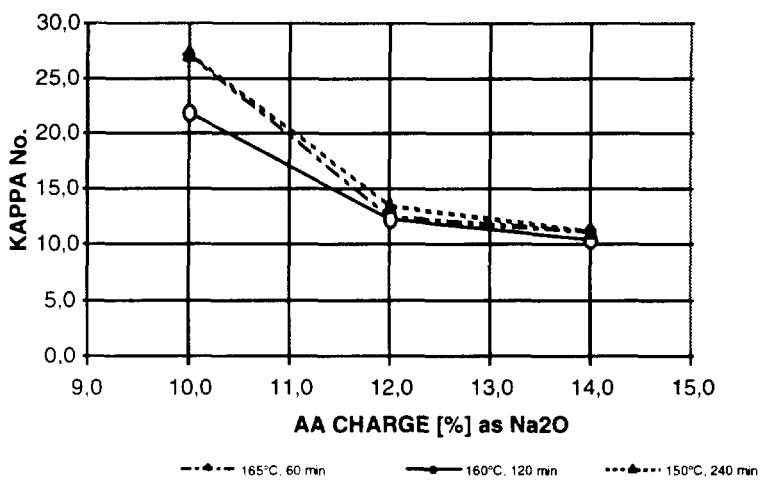
Summery of Bleaching tests for kraft-AQ Jute pulp

SEQUENCE	Lab	No. of TEST	Bright-ness absolute	Bright-ness relative	Limited Viscosity	Breakg. length at 50 SR	Fibre length weight. average	Coarse-ness	Slender-ness factor
			% ISO	%	ml/g	m	mm	mg/m	
Brown stock			44,9	44,9	1029	7814	1,65	0,125	13,20
C-E-H	ICP	1	77,90	79,90	499				
	ICP	2	75,80	77,80	539				
	ICP	3	75,50	77,50	448				
	ICP	4	76,40	78,40	916				
	ICP	5	77,40	79,40	817				
	ICP	6	79,70	81,70	811	6490	1,67	0,103	16,25
	ÖHFI	7	82,80	84,80	540	5904	1,54	0,100	15,40
C-EP-H	ICP	1	78,50	80,50	670				
	ICP	2	79,70	81,70	966				
	ICP	3	77,80	79,80	480				
	ICP	4	81,60	83,60	854	6459	1,66	0,106	15,61
	ÖHFI	5	85,00	87,20	517	5767	1,60	0,106	15,09
O-C-EO-H	ICP	1	80,50	82,50	756				
	ICP	2	79,00	81,00	583				
	ICP	3	79,10	81,10	473				
	ICP	4	83,00	85,00	792	5963	1,62	0,146	11,10
D-E-D	ICP	1	77,60	79,60	962				
	ICP	2	73,30	75,30	642				
	ICP	3	77,20	79,20	973				
	ICP	4	78,80	80,80	941				
	ICP	5	78,00	80,00	936				
D-E-D-D	ICP	4	81,70	83,70	925	6688	1,62	0,109	14,82
D-E-D	ÖHFI	6	83,50	85,80	935				
D-E-D	ÖHFI	7	85,80	87,00	937	6490	1,56	0,106	14,72
O-D-EO-D	ICP	1	78,30	80,30	924				
	ICP	2	77,50	79,50					
	ICP	3	82,40	84,40	821				
O-D-EO-D-D	ICP	3	82,70	84,70	811	6637	1,61	0,123	13,09
O-A-EOP-P	ICP	1	78,20	80,20	386				
	ÖHFI	2	82,70	82,70	550				
O-Q-EOP-P	ICP	3	75,90	77,90	869	6926	1,65	0,116	14,17
O-A-Z-P	ICP	1	76,10	78,10	800				
	ÖHFI	2	84,80	86,80	584				
O-Q-Z-P	ÖHFI	3	87,30	89,30	525	5466	1,41	0,109	12,94
Total		32							

11. DIAGRAMS

11.1 Bench scale pulping tests

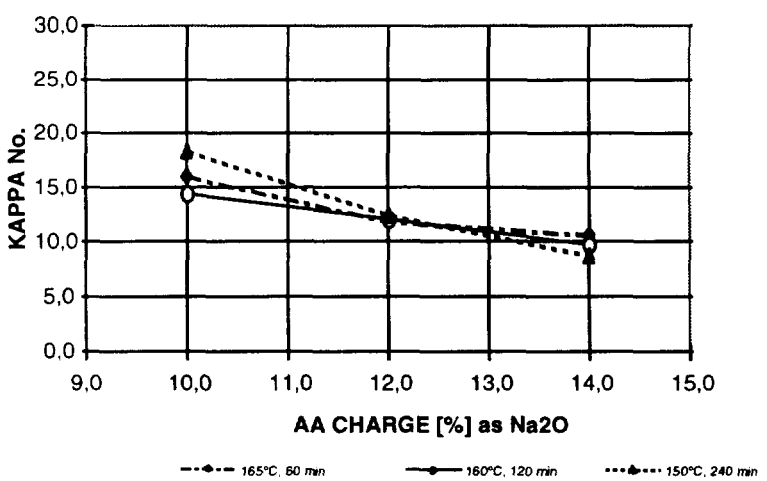
CORRELATION BETWEEN KAPPA AND AA CHARGE - KRAFT



ppt\Projekte\Triben\Final Report 1a\ Figure 1

JUTE PULPING

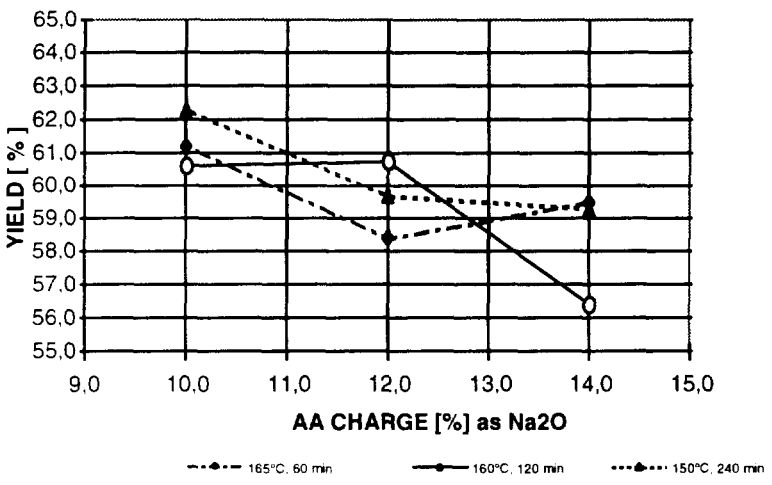
CORRELATION BETWEEN KAPPA AND AA CHARGE - KRAFT AQ



ppt\Projekte\Triben\Final Report 1a\ Figure 2

JUTE PULPING

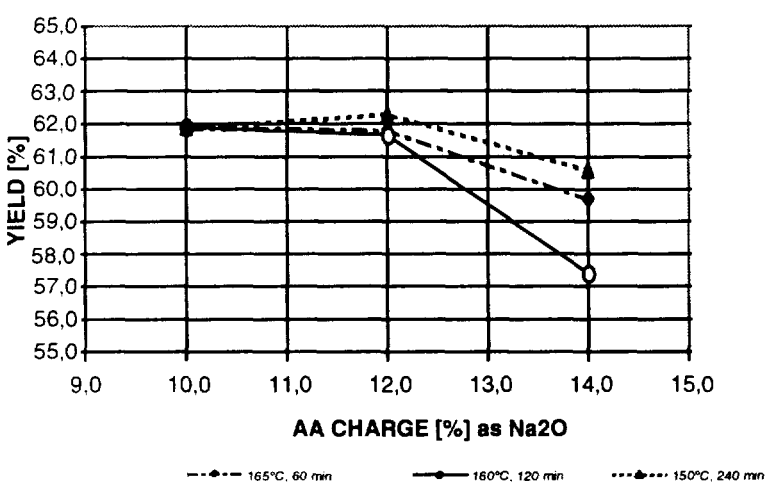
CORRELATION BETWEEN YIELD AND AA CHARGE - KRAFT



ppt\Projekte\Triben\\Final Report 1a\ Figure 3

JUTE PULPING

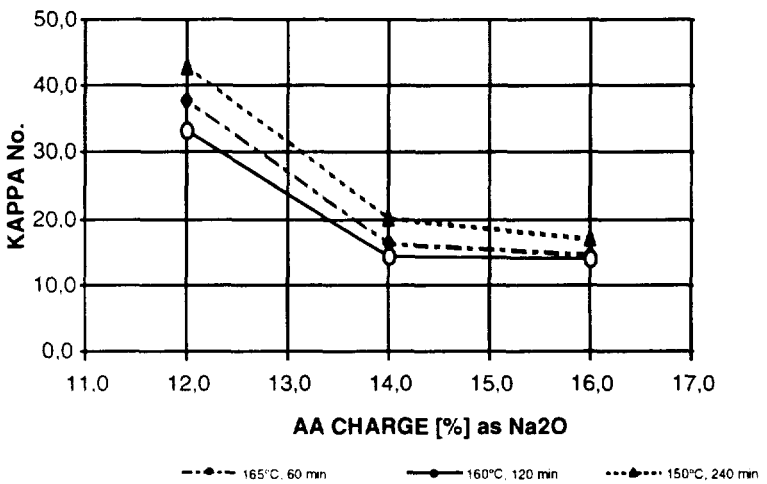
CORRELATION BETWEEN YIELD AND AA CHARGE - KRAFT AQ



ppt\Projekte\Triben\\Final Report 1a\ Figure 4

JUTE PULPING

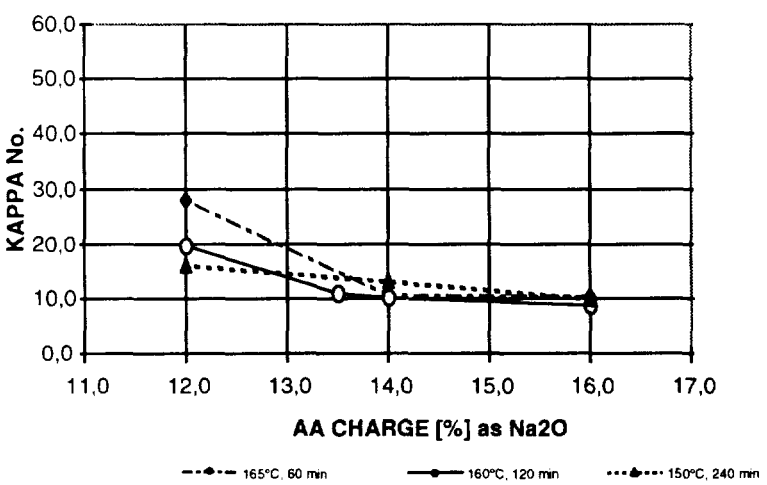
CORRELATION BETWEEN KAPPA AND AA CHARGE - CAUSTIC SODA



ppt\Projekte\Triben\Final Report 1a\ Figure 5

JUTE PULPING

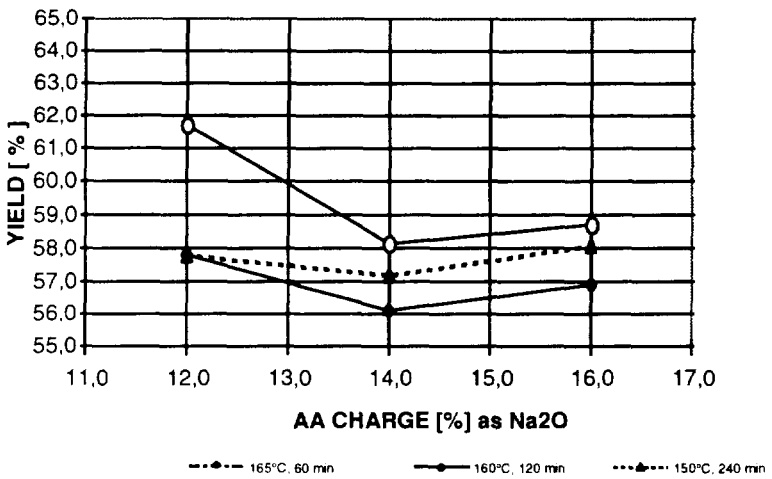
CORRELATION BETWEEN KAPPA AND AA CHARGE - SODA AQ



ppt\Projekte\Triben\Final Report 1a\ Figure 6

JUTE PULPING

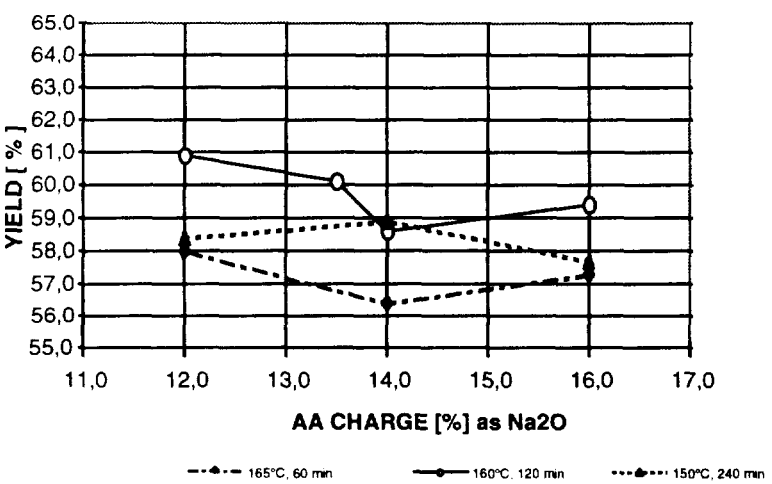
CORRELATION BETWEEN YIELD AND AA CHARGE - CAUSTIC SODA



ppt\Projekte\Triben\Final Report 1a\ Figure 7

JUTE PULPING

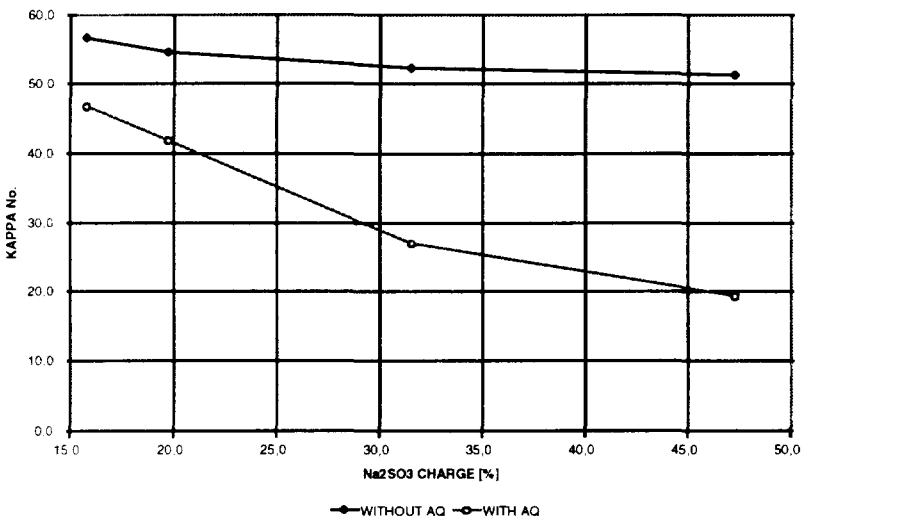
CORRELATION BETWEEN YIELD AND AA CHARGE - SODA AQ



ppt\Projekte\Triben\Final Report 1a\ Figure 8

JUTE PULPING

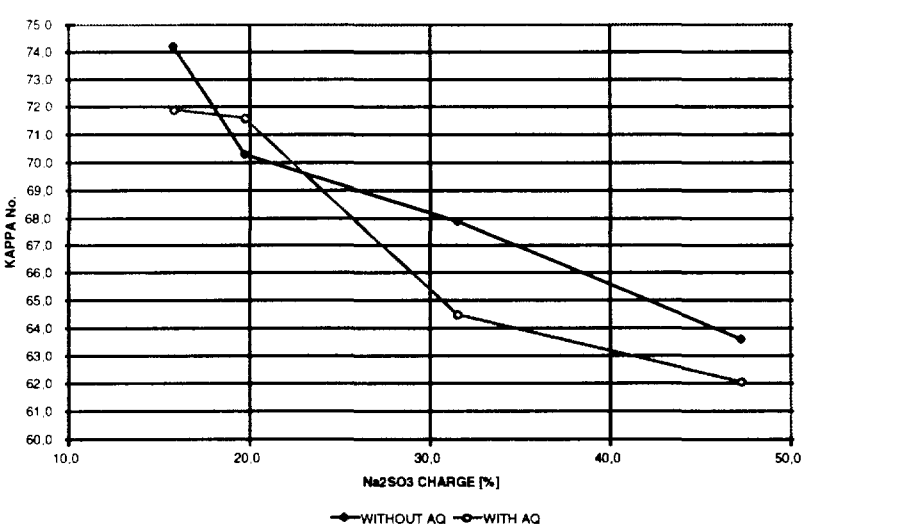
CORRELATION BETWEEN KAPPA AND Na2SO3 CHARGE



ppt\Projekte\Triben\\Final Report 1a\ Figure 9

JUTE PULPING

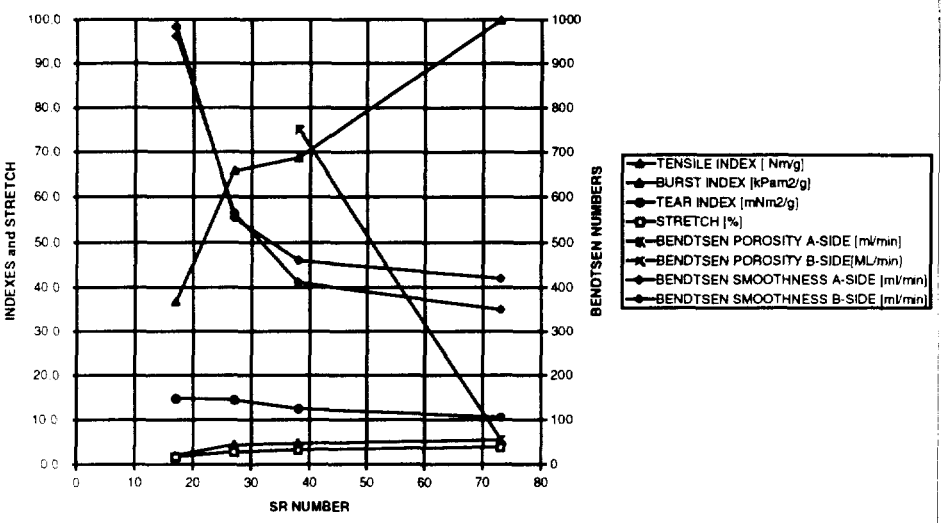
CORRELATION BETWEEN YIELD AND Na2SO3 CHARGE



ppt\Projekte\Triben\\Final Report 1a\ Figure 10

JUTE PULPING

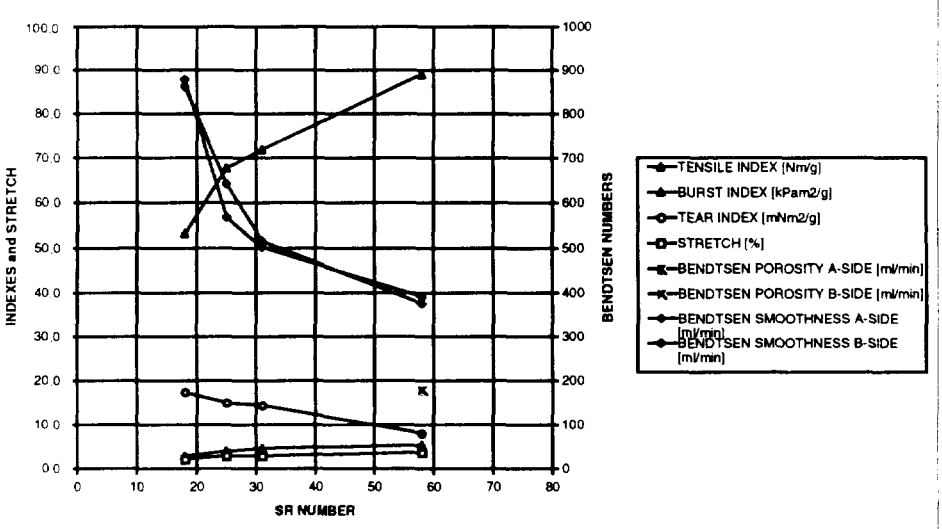
PHYSICAL PROPERTIES OF UNBLEACHED JUTE PULP [KRAFT PULPINING]



ppt\Projekte\Tribeni\Final Report 1a\ Figure 11

JUTE PULPING

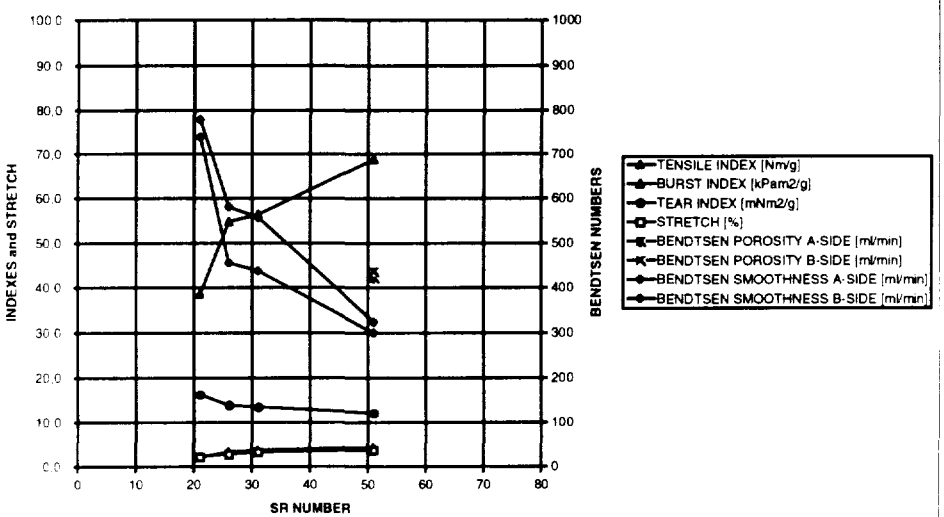
PHYSICAL PROPETIES OF UNBLEACHED JUTE PULP [KRAFT- AQ PULPING]



ppt\Projekte\Tribeni\Final Report 1a\ Figure 12

JUTE PULPING

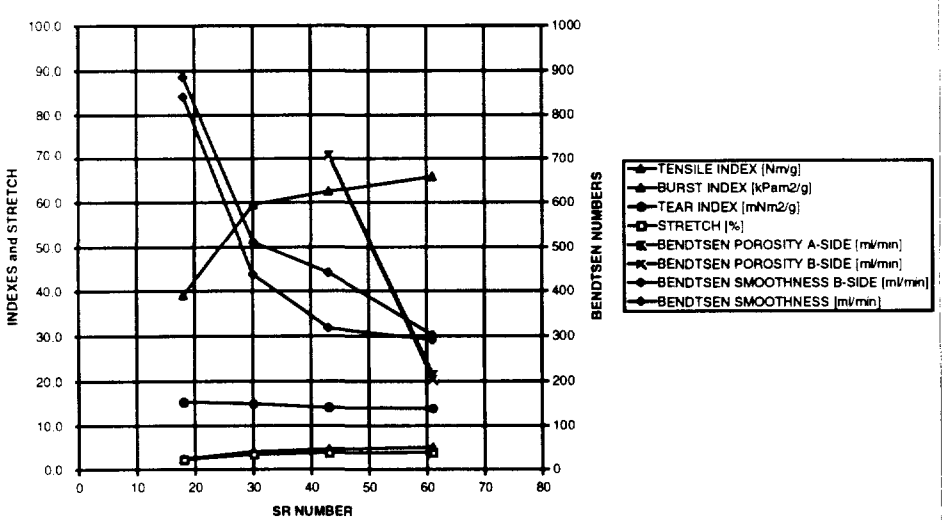
PHYSICAL PROPERTIES OF UNBLEACHED JUTE PULP [SODA PULPING]



ppt\Projekte\Triben\Final Report 1a\ Figure 13

JUTE PULPING

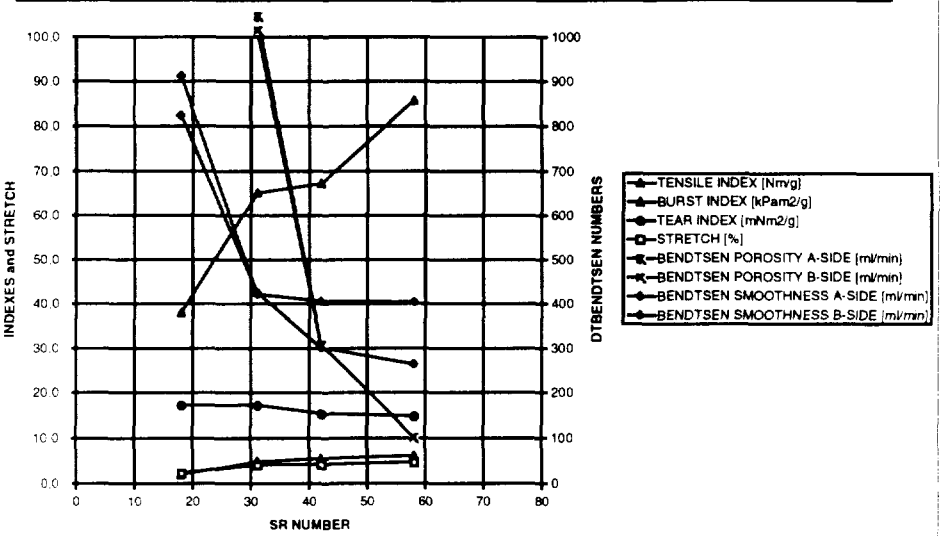
PHYSICAL PROPERTIES OF UNBLEACHED JUTE PULP [SODA-AQ PULPING]



ppt\Projekte\Triben\Final Report 1a\ Figure 14

JUTE PULPING

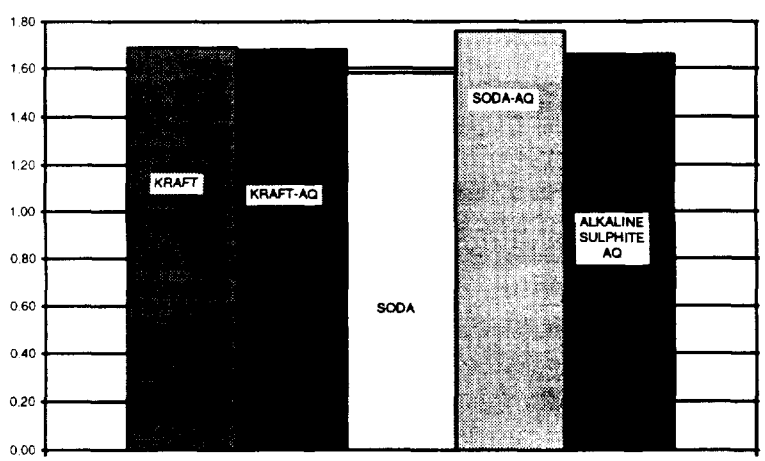
PHYSICAL PROPERTIES OF UNBLEACHED JUTE PULP [ALKALINE SULPHITE-AQ PULPING]



ppt\Projekte\Triben\Final Report 1a\ Figure 15

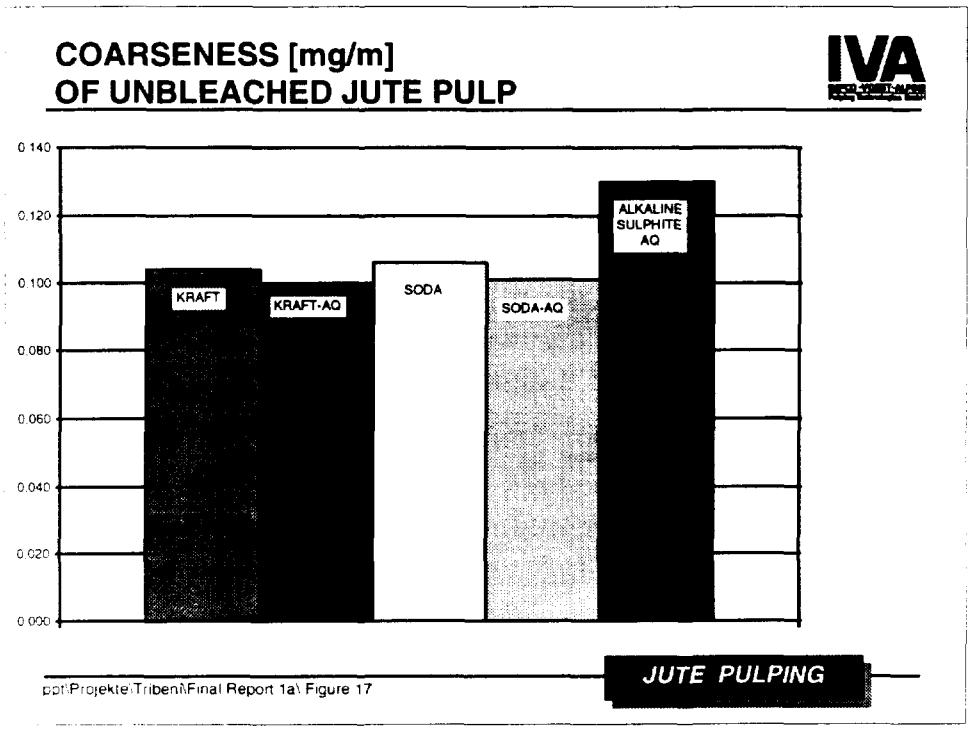
JUTE PULPING

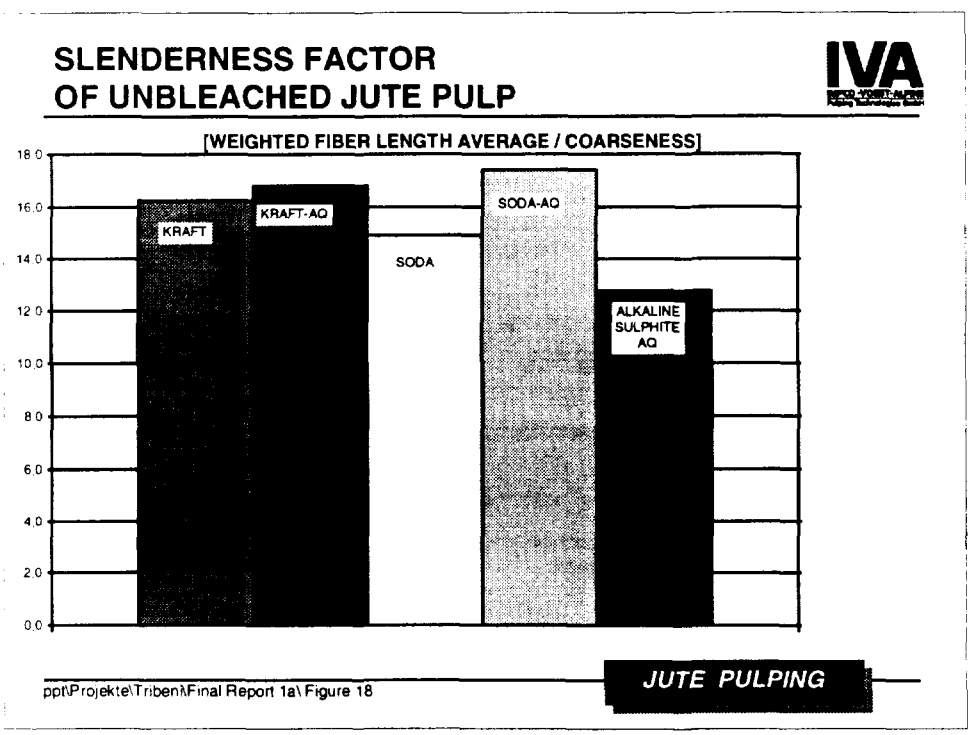
FIBER LENGTH [mm] weighted average OF UNBLEACHED JUTE PULP



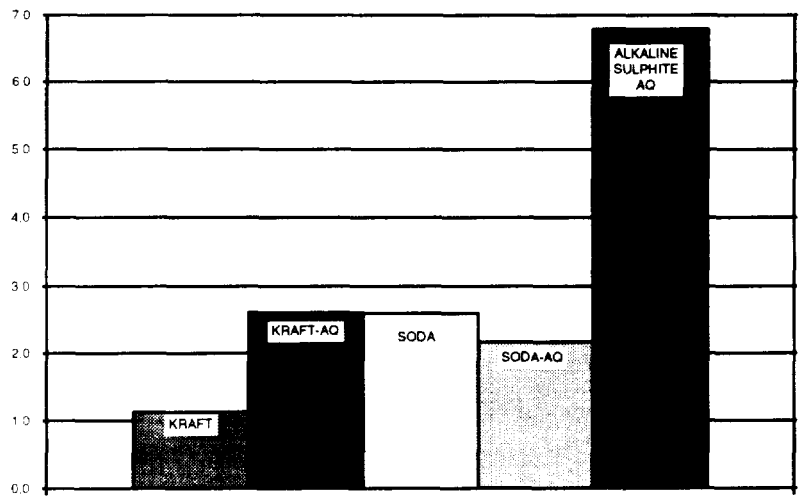
ppt\Projekte\Triben\Final Report 1a\ Figure 16

JUTE PULPING


COARSENESS [mg/m]
OF UNBLEACHED JUTE PULP
IVA
0.140
0.120
0.100
0.080
0.060
0.040
0.020
0.000
KRAFT
KRAFT-AQ
SODA
SODA-AQ
ALKALINE SULPHITE AQ
ppt\Projekte\Tribeni\Final Report 1a\ Figure 17
JUTE PULPING

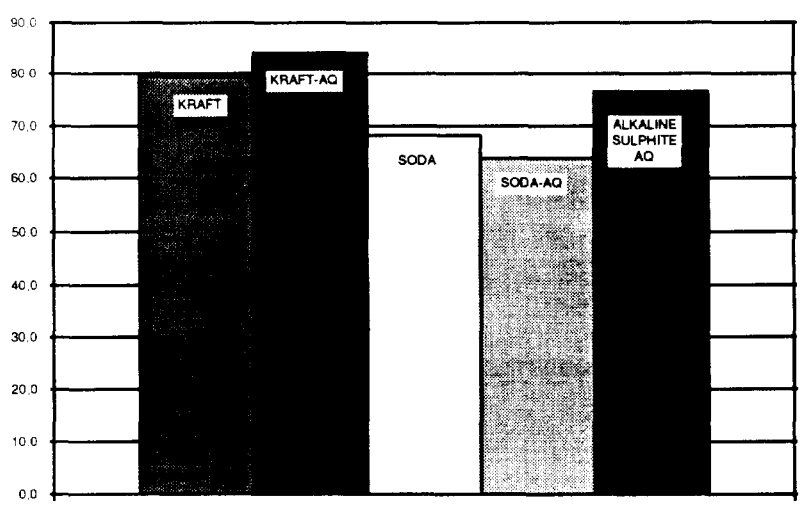

SLENDERNESS FACTOR
OF UNBLEACHED JUTE PULP
IVA
[WEIGHTED FIBER LENGTH AVERAGE / COARSENESS]
18.0
16.0
14.0
12.0
10.0
8.0
6.0
4.0
2.0
0.0
KRAFT
KRAFT-AQ
SODA
SODA-AQ
ALKALINE SULPHITE AQ
ppt\Projekte\Tribeni\Final Report 1a\ Figure 18
JUTE PULPING

ZERO SPAN TENSILE [km] OF UNBLEACHED JUTE PULP

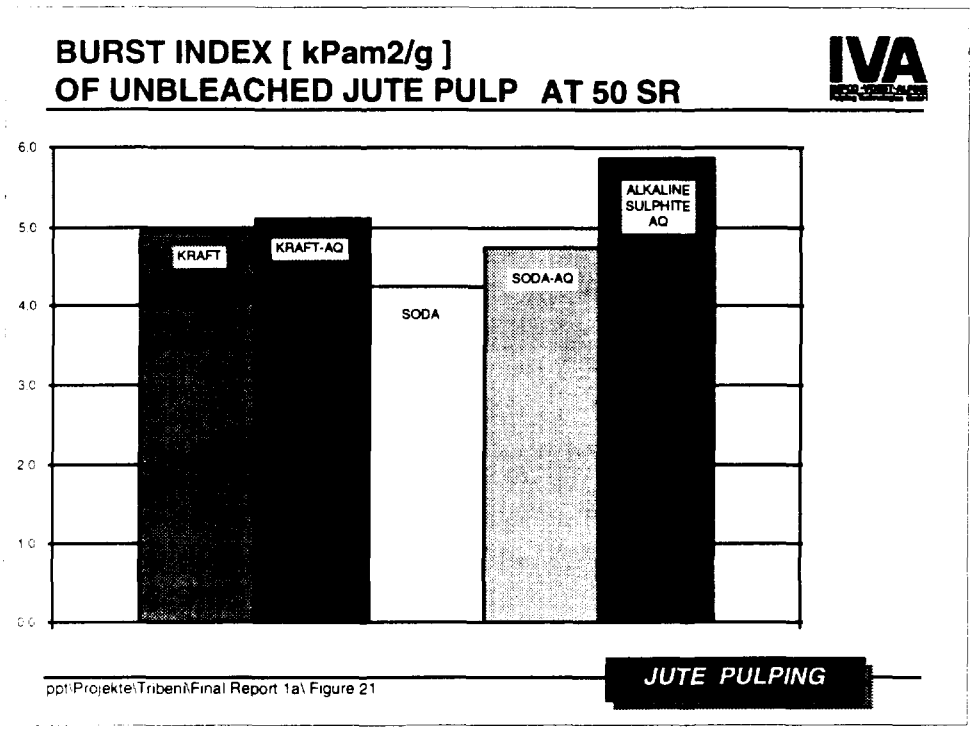


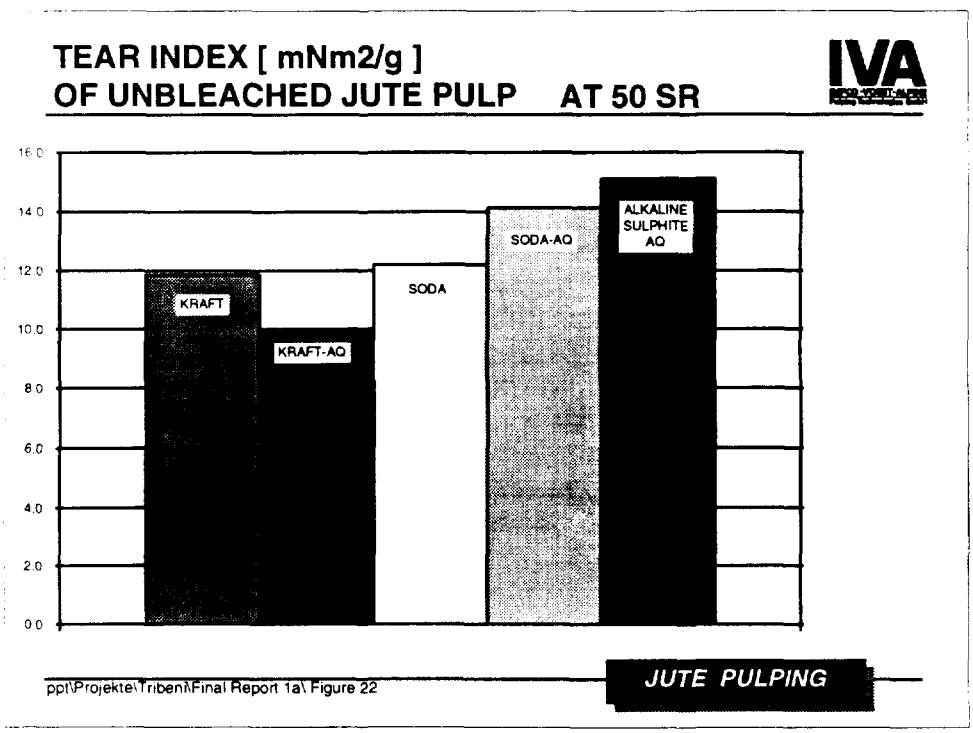
ppt\Projekte\Tribeni\Final Report 1a\ Figure 19

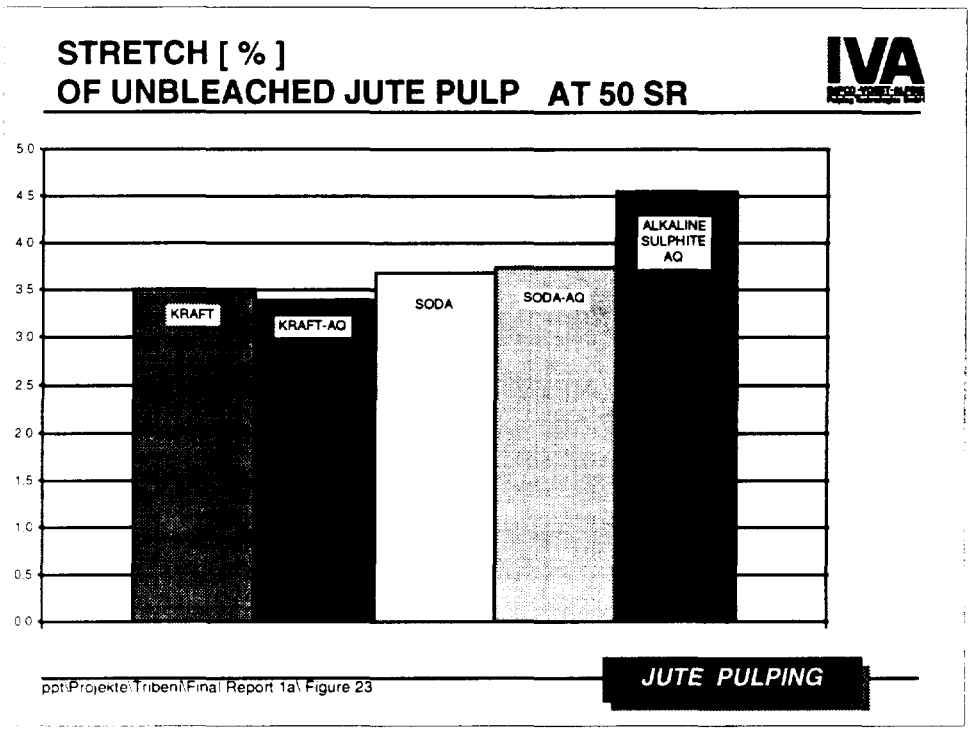
TENSILE INDEX [Nm/g] OF UNBLEACHED JUTE PULP AT 50 SR

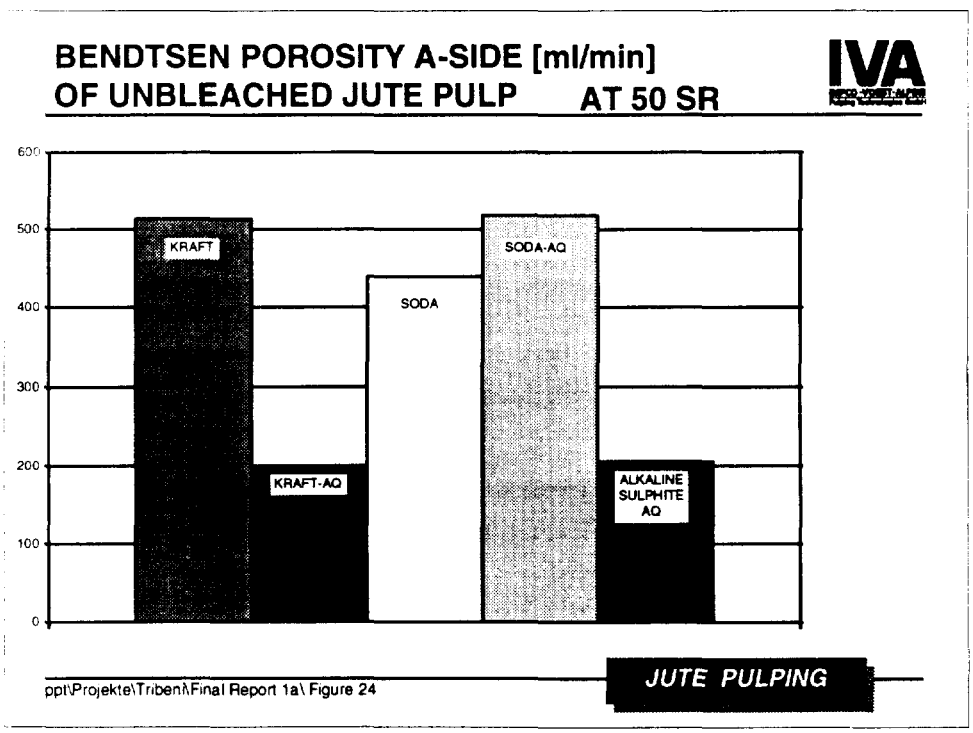


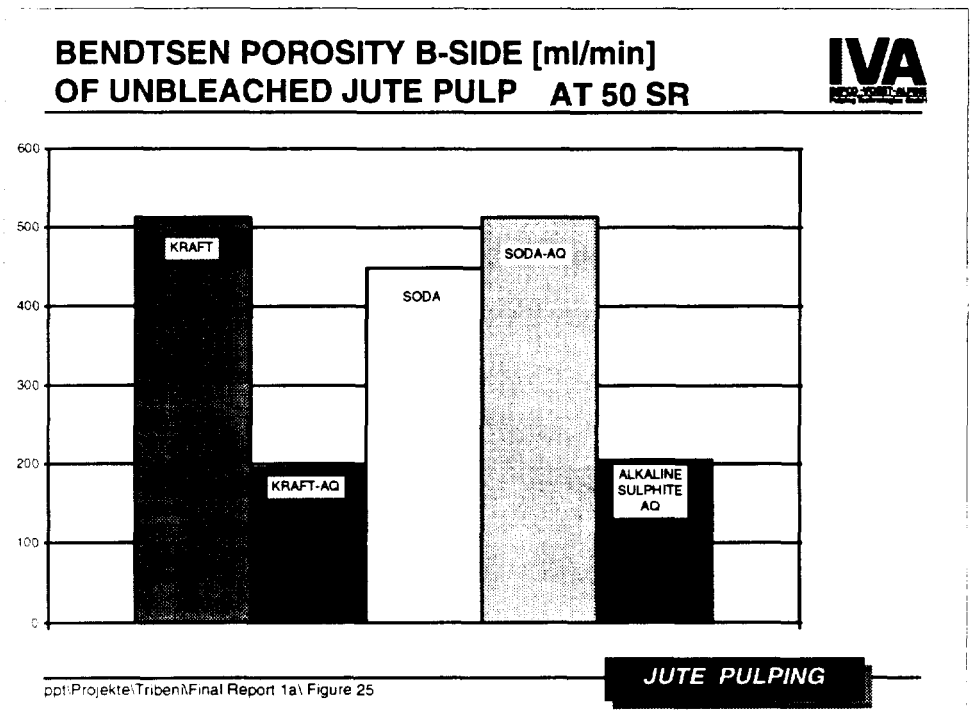
ppt\Projekte\Tribeni\Final Report 1a\ Figure 20

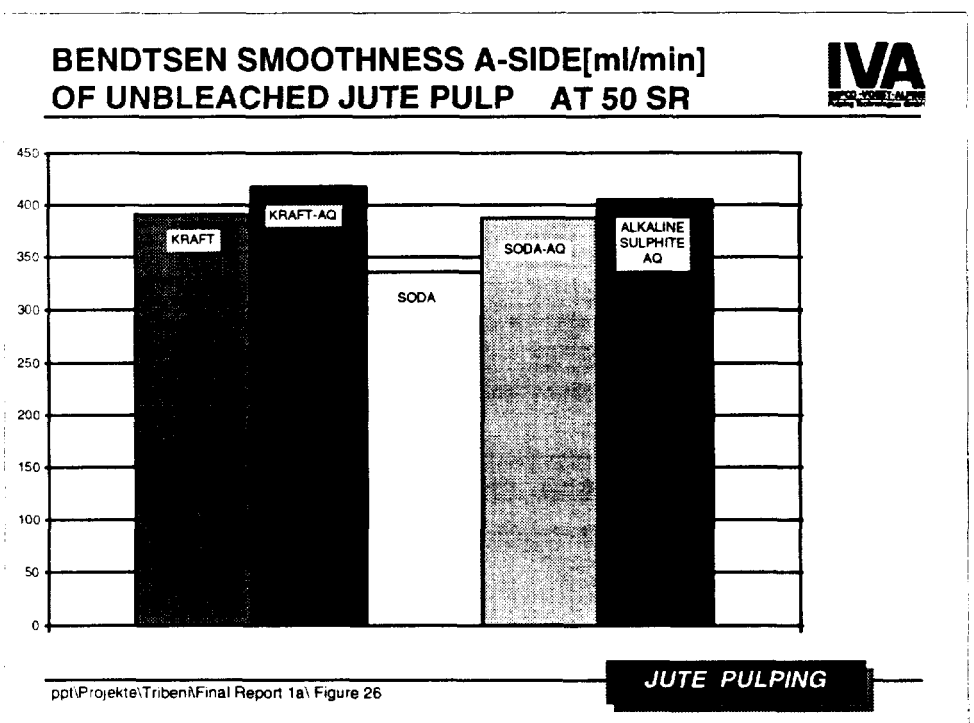

BURST INDEX [kPam2/g]
OF UNBLEACHED JUTE PULP AT 50 SR
IVA
6.0
5.0
4.0
3.0
2.0
1.0
0.0
KRAFT
KRAFT-AQ
SODA
SODA-AQ
ALKALINE SULPHITE AQ
ppt\Projekte\Tribeni\Final Report 1a\ Figure 21
JUTE PULPING


TEAR INDEX [mNm2/g]
OF UNBLEACHED JUTE PULP AT 50 SR
IVA
16.0
14.0
12.0
10.0
8.0
6.0
4.0
2.0
0.0
KRAFT
KRAFT-AQ
SODA
SODA-AQ
ALKALINE SULPHITE AQ
ppt\Projekte\Tribeni\Final Report 1a\ Figure 22
JUTE PULPING

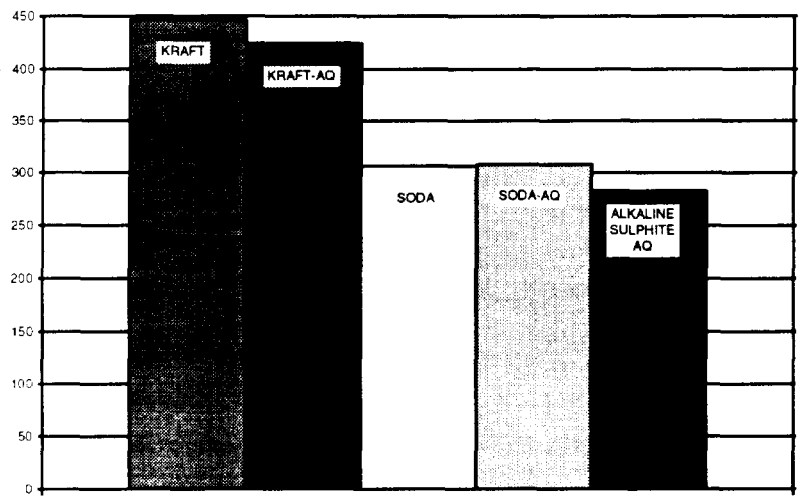

STRETCH [%]
OF UNBLEACHED JUTE PULP AT 50 SR
IVA
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
KRAFT
KRAFT-AQ
SODA
SODA-AQ
ALKALINE SULPHITE AQ
ppt\Projekte\Triben\Final Report 1a\ Figure 23
JUTE PULPING


BENDTSEN POROSITY A-SIDE [ml/min]
OF UNBLEACHED JUTE PULP AT 50 SR
IVA
600
500
400
300
200
100
0
KRAFT
KRAFT-AQ
SODA
SODA-AQ
ALKALINE SULPHITE AQ
ppt\Projekte\Triben\Final Report 1a\ Figure 24
JUTE PULPING


BENDTSEN POROSITY B-SIDE [ml/min]
OF UNBLEACHED JUTE PULP AT 50 SR
IVA
600
500
400
300
200
100
0
KRAFT
KRAFT-AQ
SODA
SODA-AQ
ALKALINE SULPHITE AQ
ppt\Projekte\Triben\Final Report 1a\ Figure 25
JUTE PULPING


BENDTSEN SMOOTHNESS A-SIDE[ml/min]
OF UNBLEACHED JUTE PULP AT 50 SR
IVA
450
400
350
300
250
200
150
100
50
0
KRAFT
KRAFT-AQ
SODA
SODA-AQ
ALKALINE SULPHITE AQ
ppt\Projekte\Triben\Final Report 1a\ Figure 26
JUTE PULPING

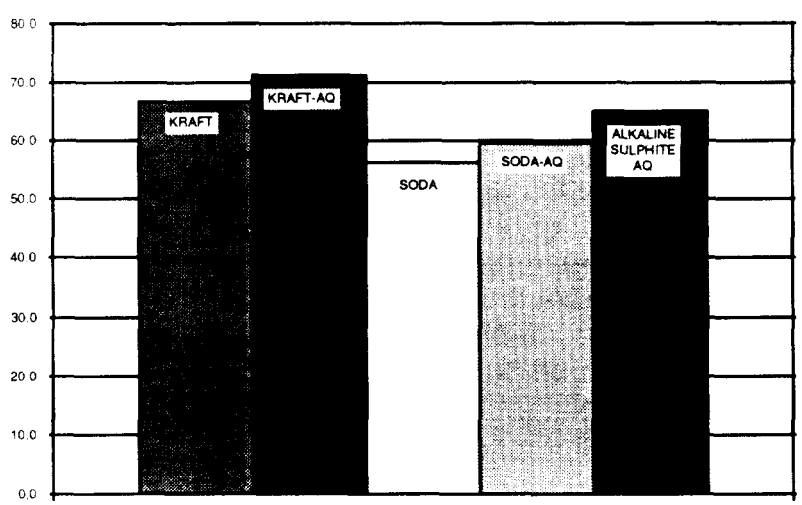
BENDTSEN SMOOTHNESS B-SIDE[ml/min] OF UNBLEACHED JUTE PULP AT 50 SR



ppt\Projekte\Triben\\Final Report 1a\ Figure 27

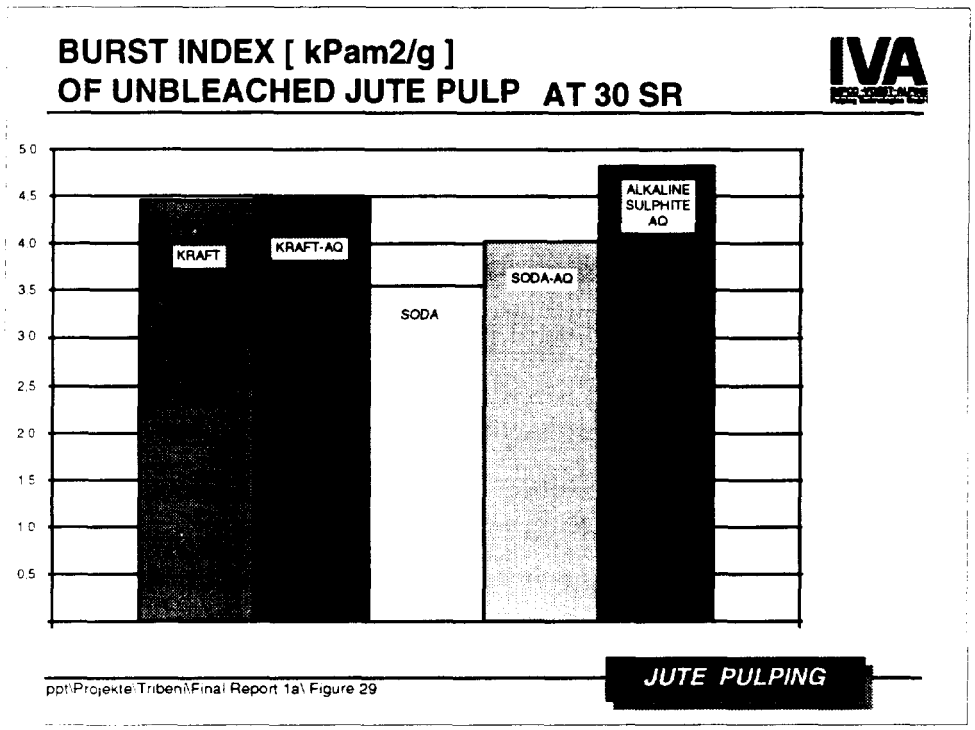
JUTE PULPING

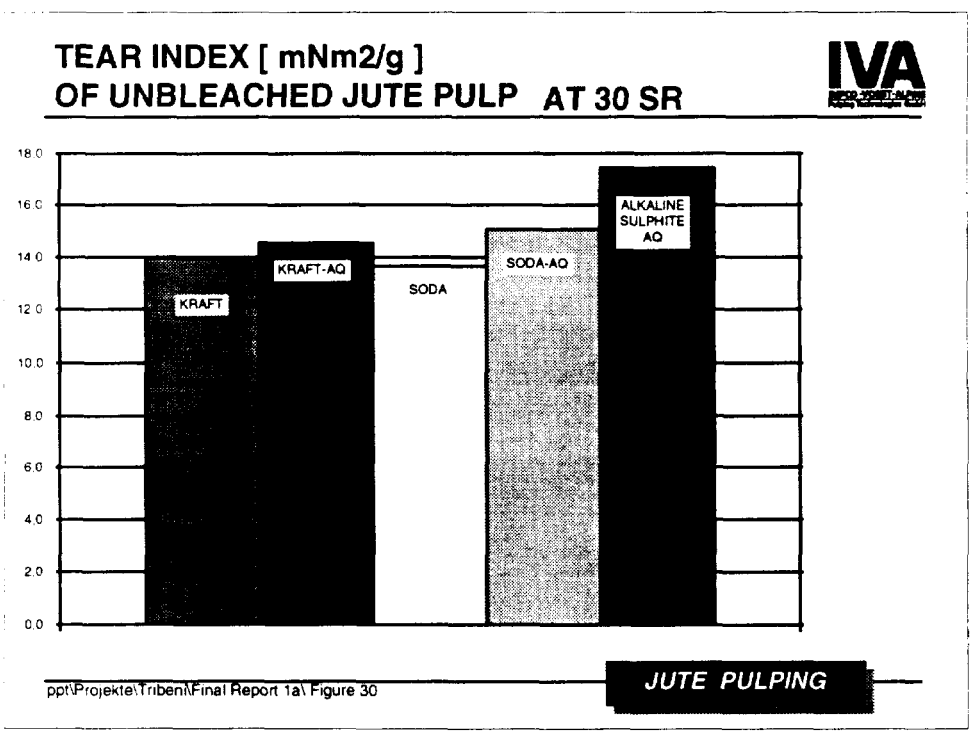
TENSILE INDEX [Nm/g] OF UNBLEACHED JUTE PULP AT 30 SR

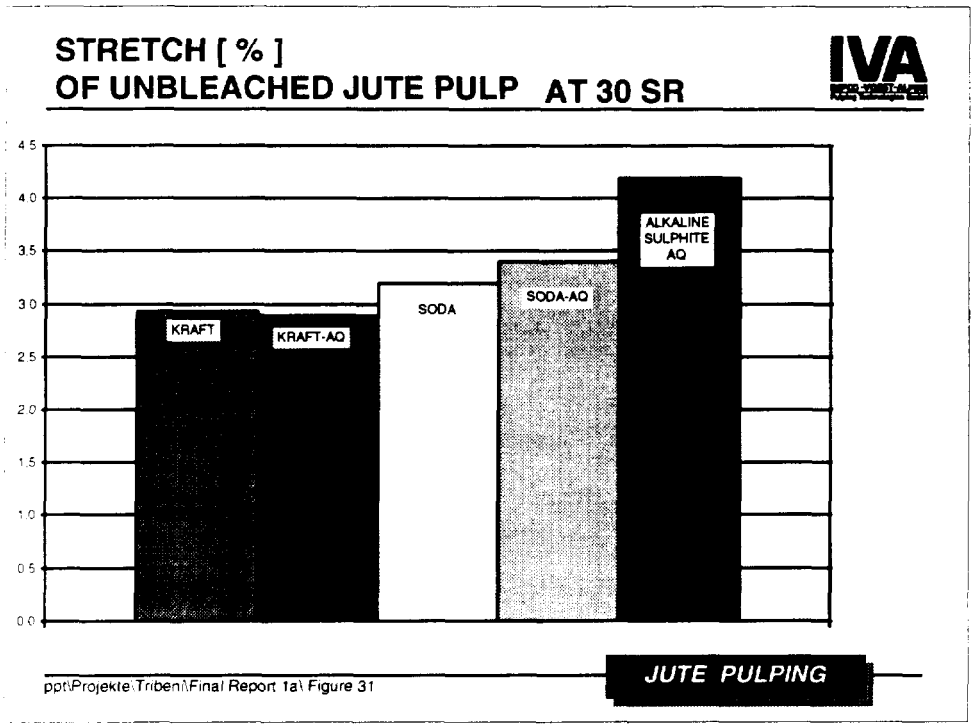


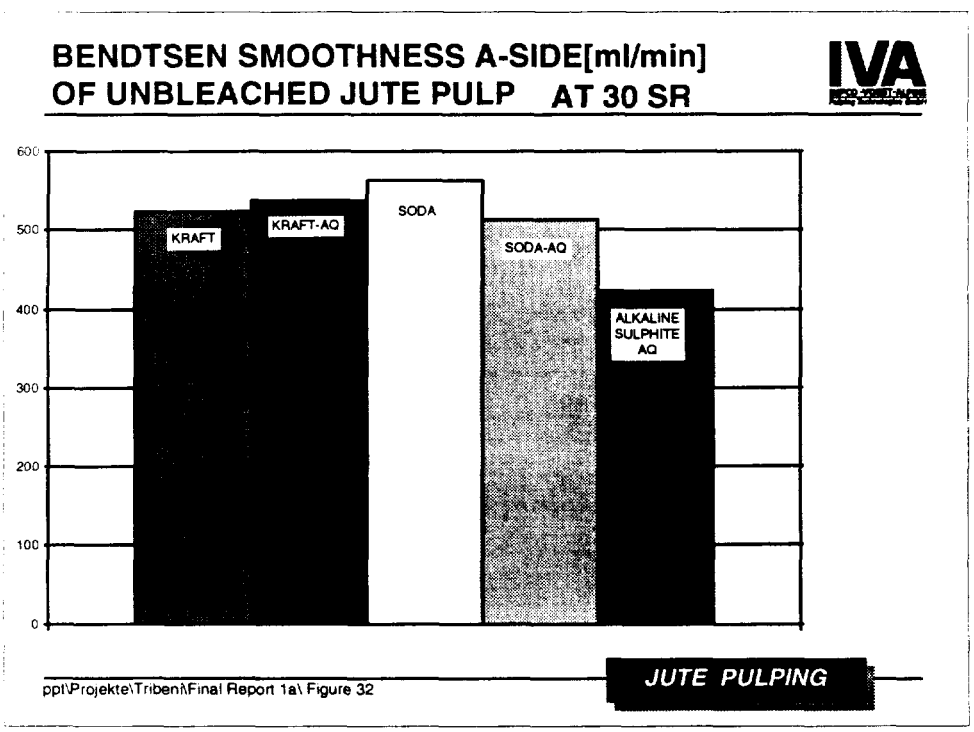
ppt\Projekte\Triben\\Final Report 1a\ Figure 28

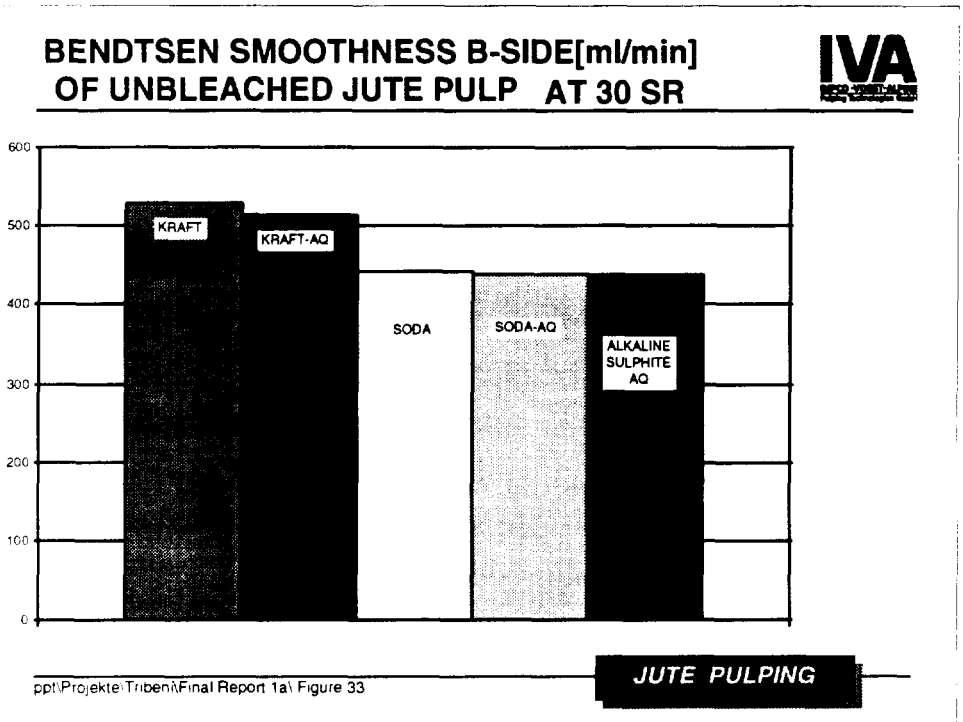
JUTE PULPING

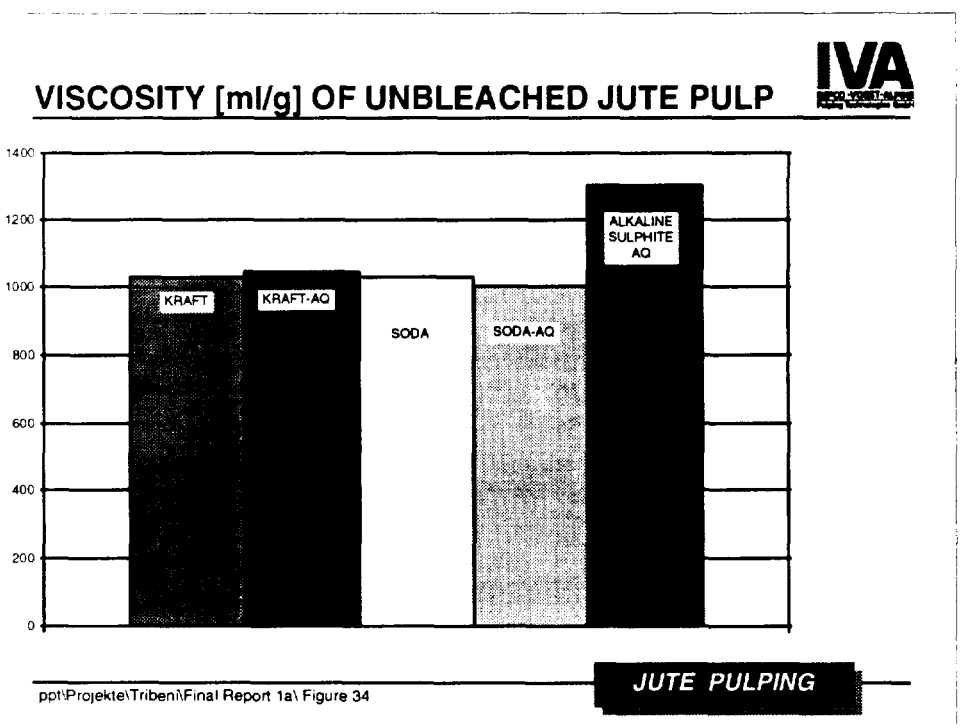

BURST INDEX [kPam2/g]
OF UNBLEACHED JUTE PULP AT 30 SR
IVA
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
KRAFT
KRAFT-AQ
SODA
SODA-AQ
ALKALINE SULPHITE AQ
ppt\Projekte\Tribeni\Final Report 1a\ Figure 29
JUTE PULPING


TEAR INDEX [mNm2/g]
OF UNBLEACHED JUTE PULP AT 30 SR
IVA
18.0
16.0
14.0
12.0
10.0
8.0
6.0
4.0
2.0
0.0
KRAFT
KRAFT-AQ
SODA
SODA-AQ
ALKALINE SULPHITE AQ
ppt\Projekte\Tribeni\Final Report 1a\ Figure 30
JUTE PULPING

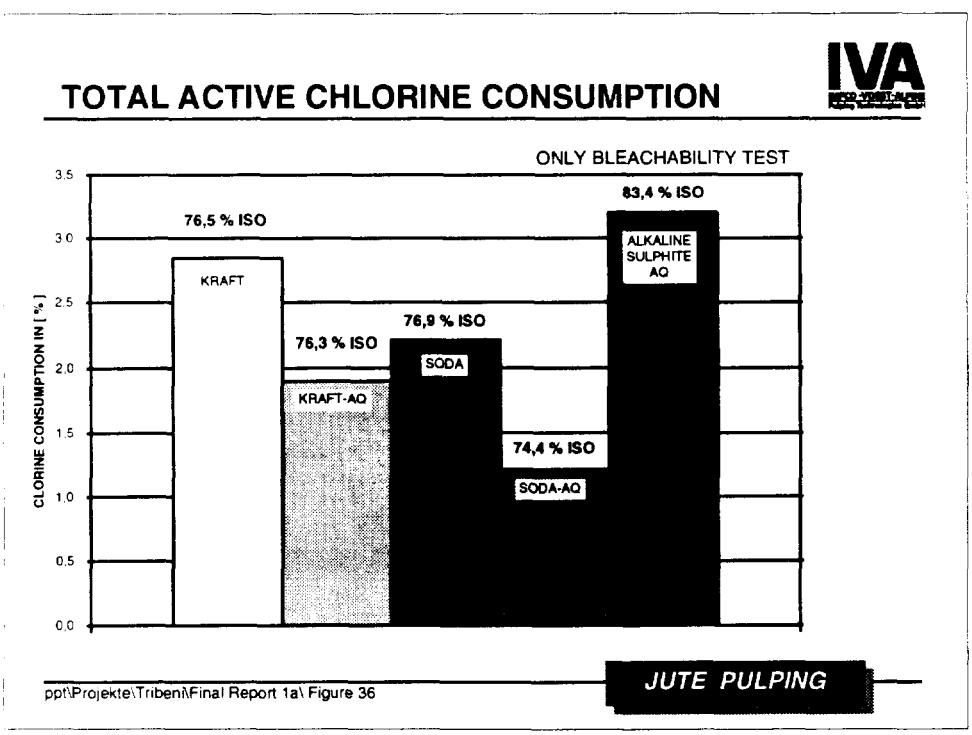

STRETCH [%]
OF UNBLEACHED JUTE PULP AT 30 SR
IVA
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
KRAFT
KRAFT-AQ
SODA
SODA-AQ
ALKALINE SULPHITE AQ
ppt\Projekte\Triben\Final Report 1a\ Figure 31
JUTE PULPING


BENDTSEN SMOOTHNESS A-SIDE[ml/min]
OF UNBLEACHED JUTE PULP AT 30 SR
IVA
600
500
400
300
200
100
0
KRAFT
KRAFT-AQ
SODA
SODA-AQ
ALKALINE SULPHITE AQ
ppt\Projekte\Triben\Final Report 1a\ Figure 32
JUTE PULPING

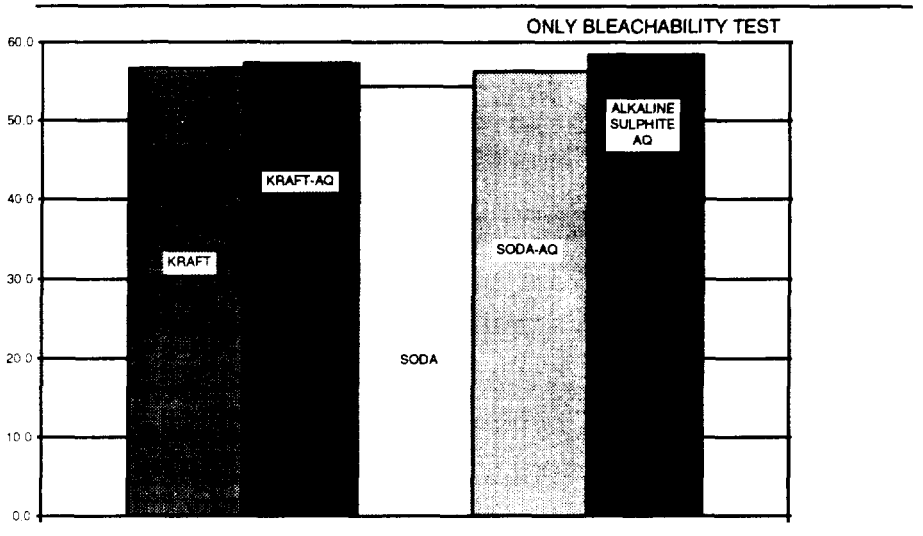

BENDTSEN SMOOTHNESS B-SIDE[ml/min]
OF UNBLEACHED JUTE PULP AT 30 SR
IVA
600
500
400
300
200
100
0
KRAFT
KRAFT-AQ
SODA
SODA-AQ
ALKALINE SULPHITE AQ
ppt\Projekte\Triben\Final Report 1a\ Figure 33
JUTE PULPING


VISCOSITY [ml/g] OF UNBLEACHED JUTE PULP
IVA
1400
1200
1000
800
600
400
200
0
KRAFT
KRAFT-AQ
SODA
SODA-AQ
ALKALINE SULPHITE AQ
ppt\Projekte\Triben\Final Report 1a\ Figure 34
JUTE PULPING

11.2 Bleachability tests


TOTAL ACTIVE CHLORINE CONSUMPTION
IVA
ONLY BLEACHABILITY TEST
CLORINE CONSUMPTION IN [%]
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
76,5 % ISO
KRAFT
76,3 % ISO
KRAFT-AQ
76,9 % ISO
SODA
74,4 % ISO
SODA-AQ
83,4 % ISO
ALKALINE SULPHITE AQ
ppt\Projekte\Tribeni\Final Report 1a\ Figure 36
JUTE PULPING

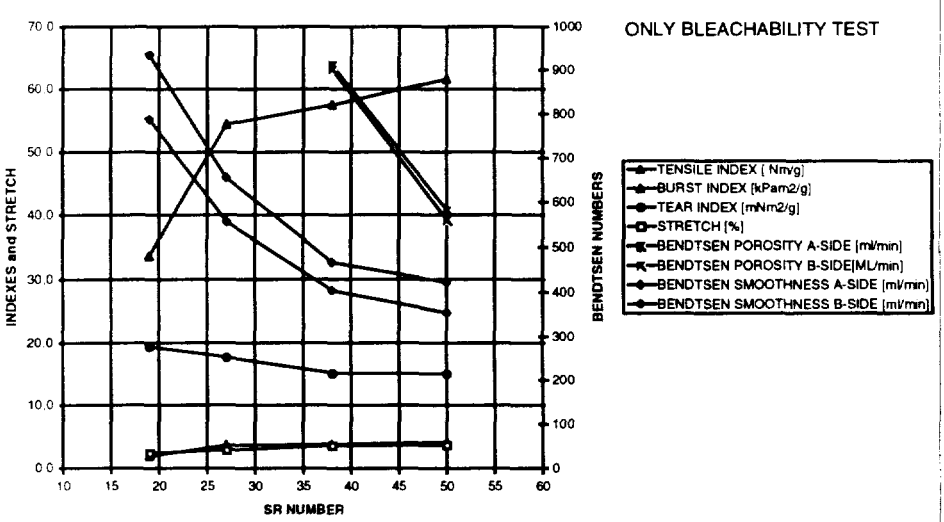
BLEACHED PULP TOTAL YIELD [%]



ppt\Projekte\Triben\Final Report 1a\ Figure 37

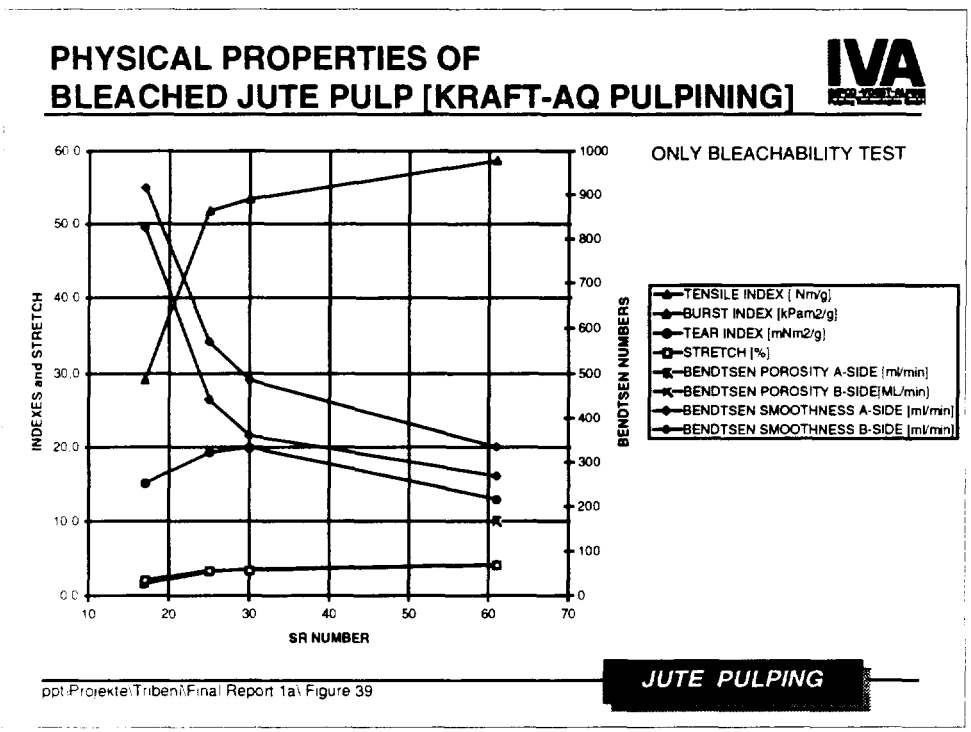
JUTE PULPING

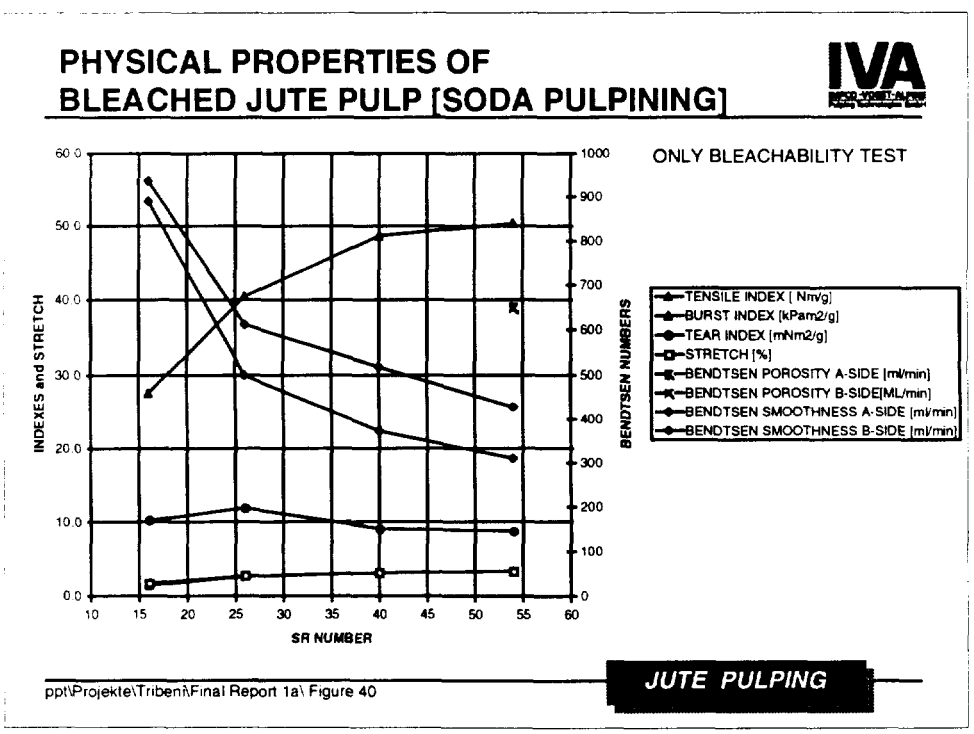
PHYSICAL PROPERTIES OF BLEACHED JUTE PULP [KRAFT PULPINING]



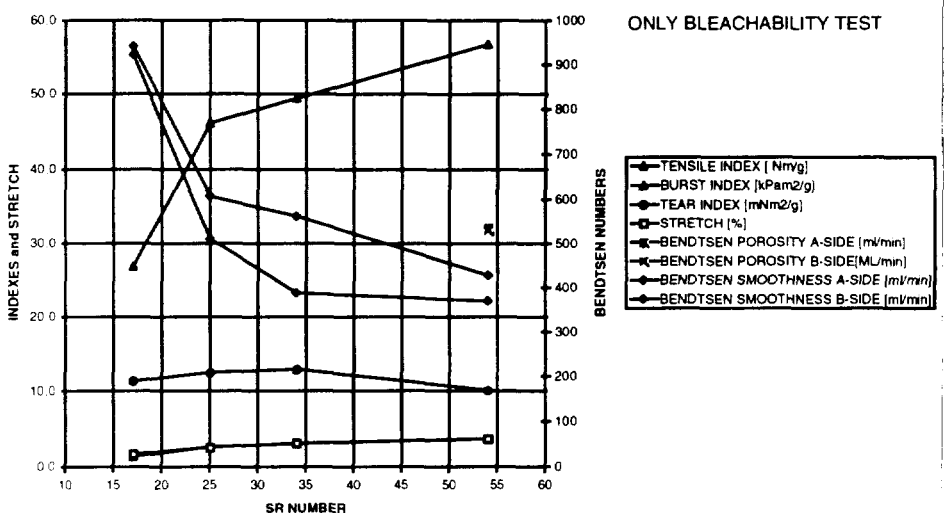
ppt\Projekte\Triben\Final Report 1a\ Figure 38

JUTE PULPING


PHYSICAL PROPERTIES OF
BLEACHED JUTE PULP [KRAFT-AQ PULPINING]
IVA
ONLY BLEACHABILITY TEST
INDEXES and STRETCH
BENDTSEN NUMBERS
SR NUMBER
TENSILE INDEX [Nm/g]
BURST INDEX [kPam2/g]
TEAR INDEX [mNm2/g]
STRETCH [%]
BENDTSEN POROSITY A-SIDE [ml/min]
BENDTSEN POROSITY B-SIDE[ML/min]
BENDTSEN SMOOTHNESS A-SIDE [ml/min]
BENDTSEN SMOOTHNESS B-SIDE [ml/min]
ppt\Projekte\Triben\Final Report 1a\ Figure 39
JUTE PULPING


PHYSICAL PROPERTIES OF
BLEACHED JUTE PULP [SODA PULPINING]
IVA
ONLY BLEACHABILITY TEST
INDEXES and STRETCH
BENDTSEN NUMBERS
SR NUMBER
TENSILE INDEX [Nm/g]
BURST INDEX [kPam2/g]
TEAR INDEX [mNm2/g]
STRETCH [%]
BENDTSEN POROSITY A-SIDE [ml/min]
BENDTSEN POROSITY B-SIDE[ML/min]
BENDTSEN SMOOTHNESS A-SIDE [ml/min]
BENDTSEN SMOOTHNESS B-SIDE [ml/min]
ppt\Projekte\Triben\Final Report 1a\ Figure 40
JUTE PULPING

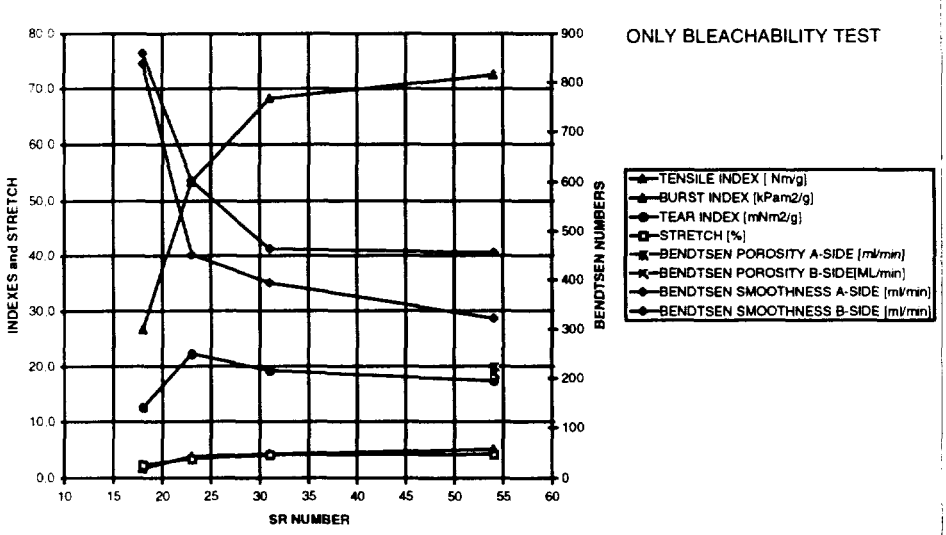
PHYSICAL PROPERTIES OF BLEACHED JUTE PULP [SODA-AQ PULPINING]



ppt\Projekte\Triben\Final Report 1a\ Figure 41

JUTE PULPING

PHYSICAL PROPERTIES OF BLEACHED JUTE PULP [ALKALINE SULPHATE-AQ PULPINING]



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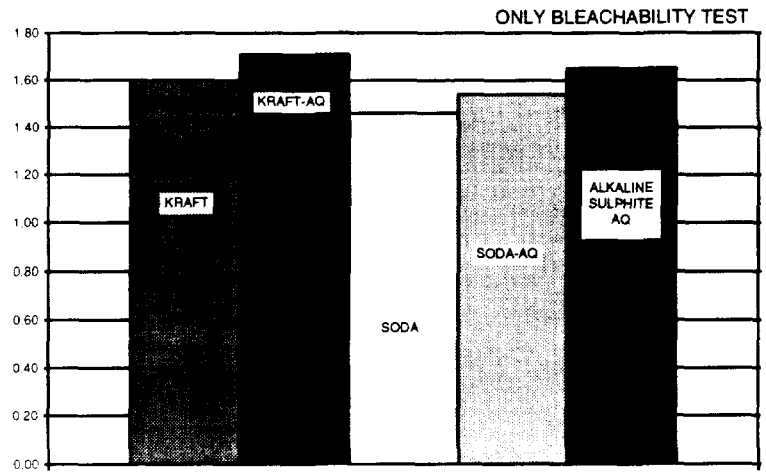
JUTE PULPING

FIBER LENGTH [mm] weigthed average OF BLEACHED JUTE PULP



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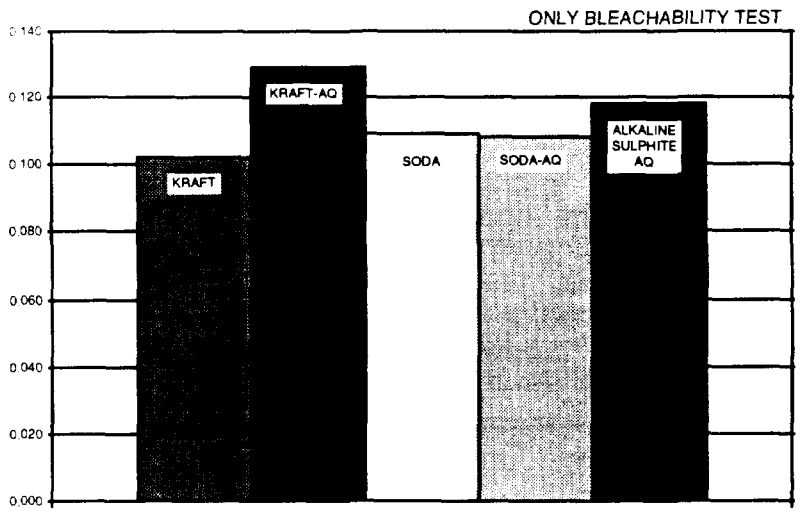
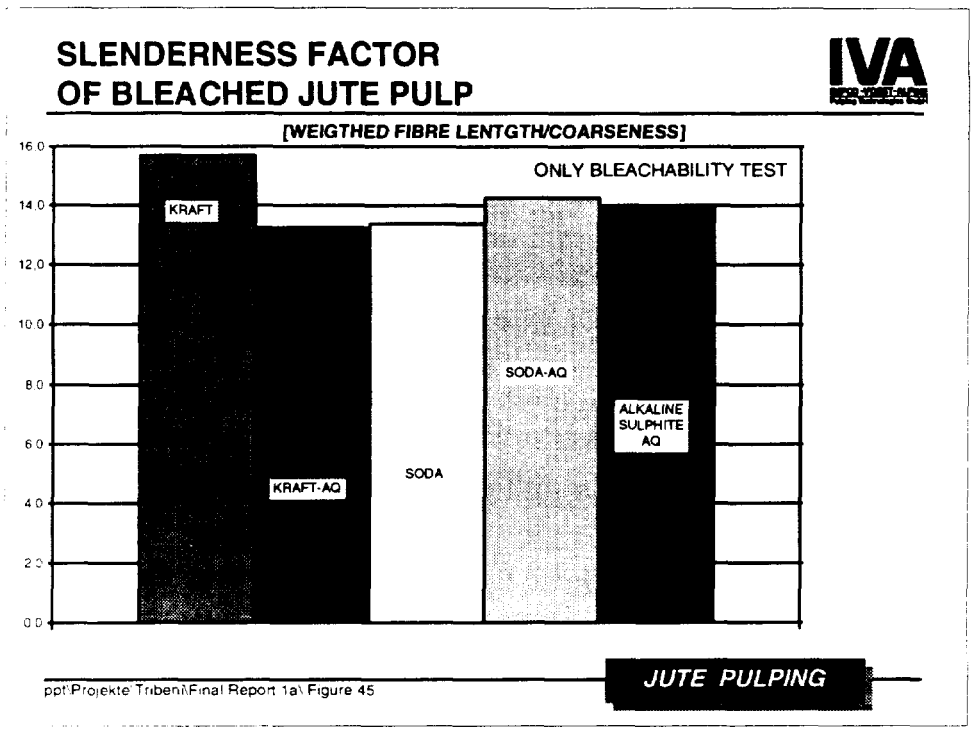
JUTE PULPING

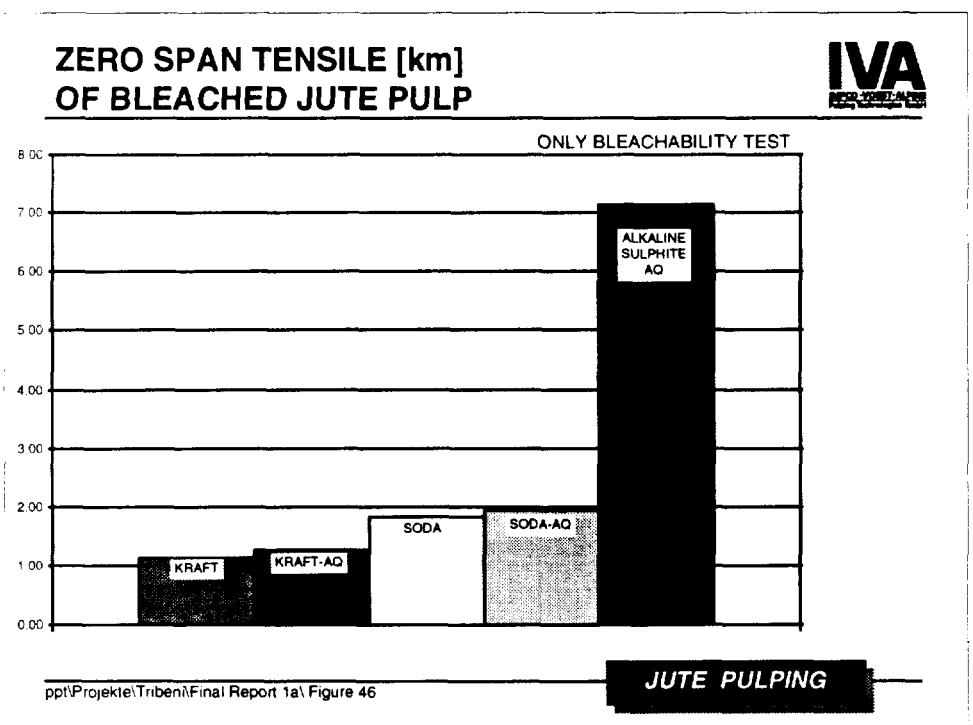
COARSENESS lmg/m] OF BLEACHED JUTE PULP

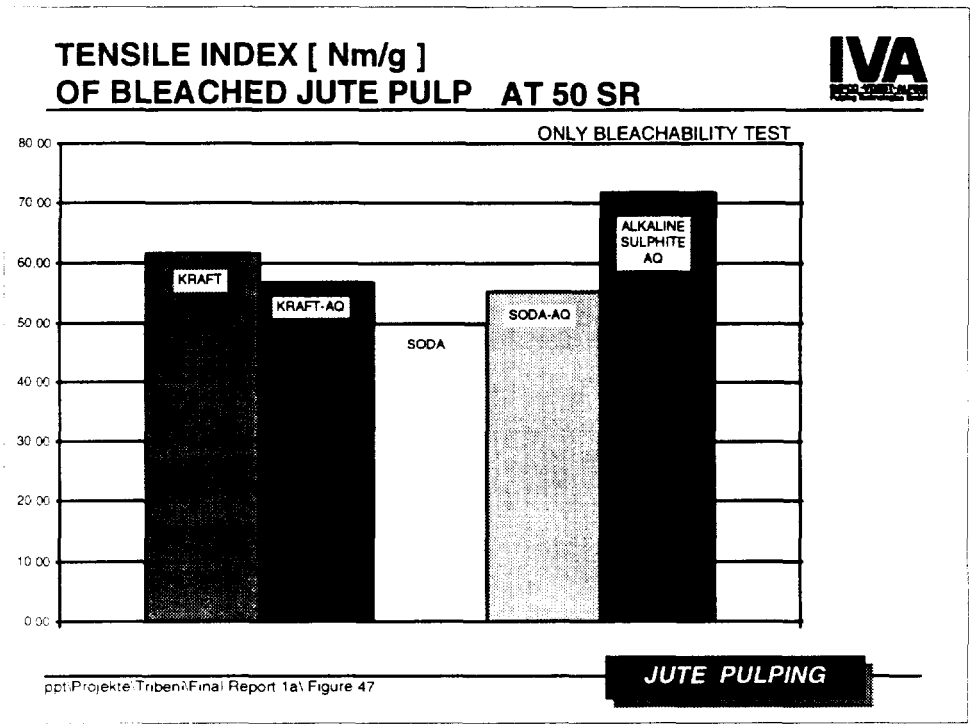


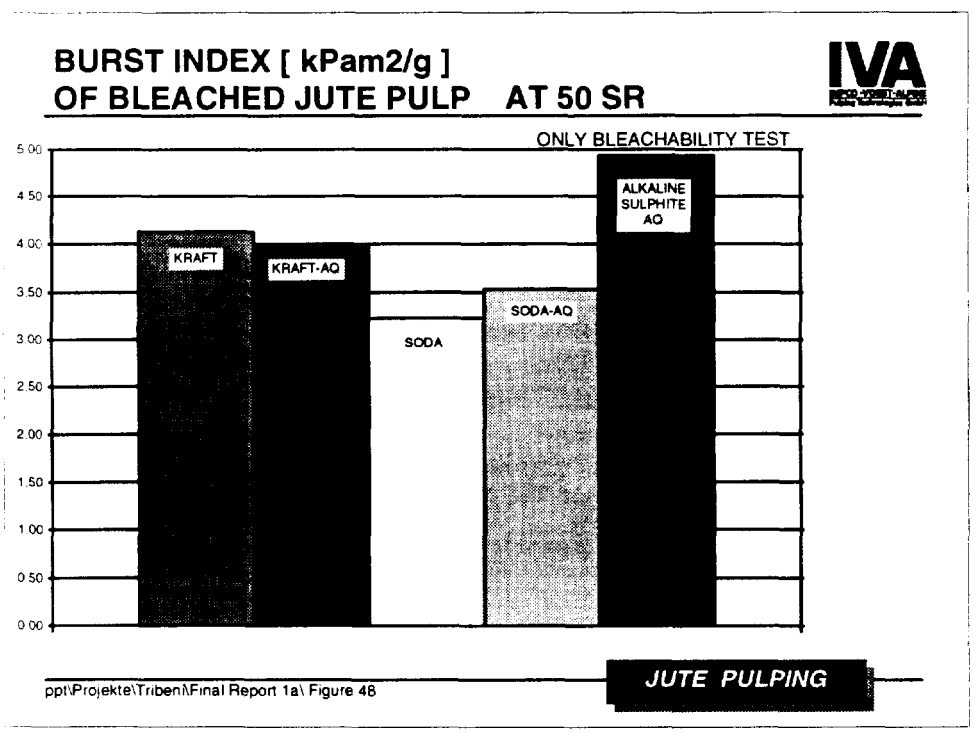
ppt\Projekte\Triben\Final Report 1a\ Figure 44

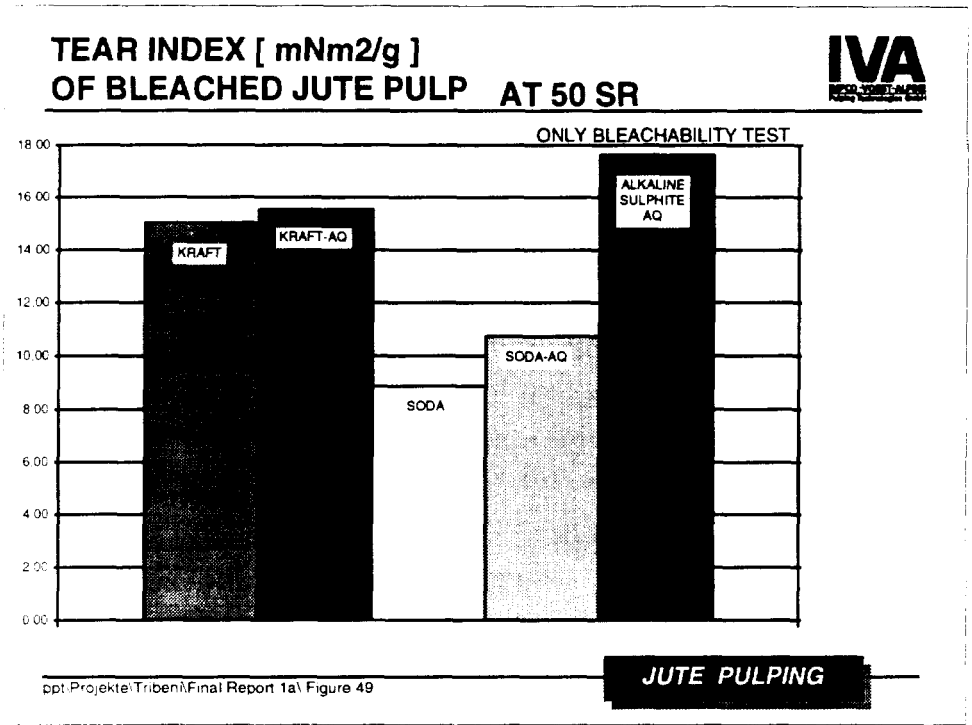
JUTE PULPING

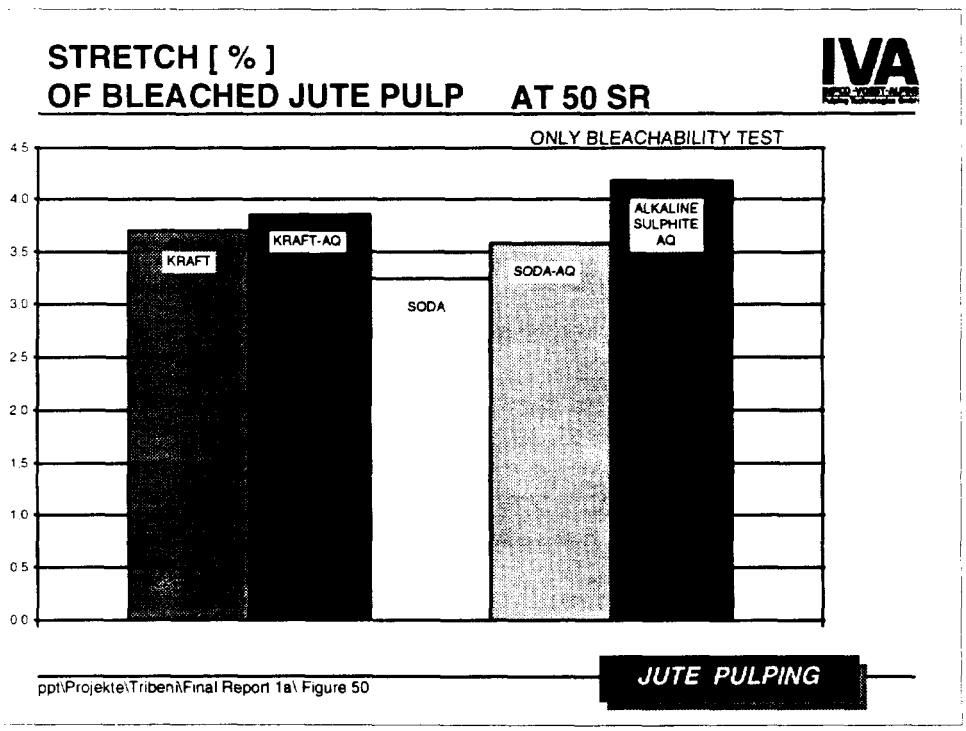

SLENDERNESS FACTOR
OF BLEACHED JUTE PULP
IVA
[WEIGTHED FIBRE LENTGTH/COARSENESS]
ONLY BLEACHABILITY TEST
16.0
14.0
12.0
10.0
8.0
6.0
4.0
2.0
0.0
KRAFT
KRAFT-AQ
SODA
SODA-AQ
ALKALINE SULPHITE AQ
ppt\Projekte Tribeni\Final Report 1a\ Figure 45
JUTE PULPING

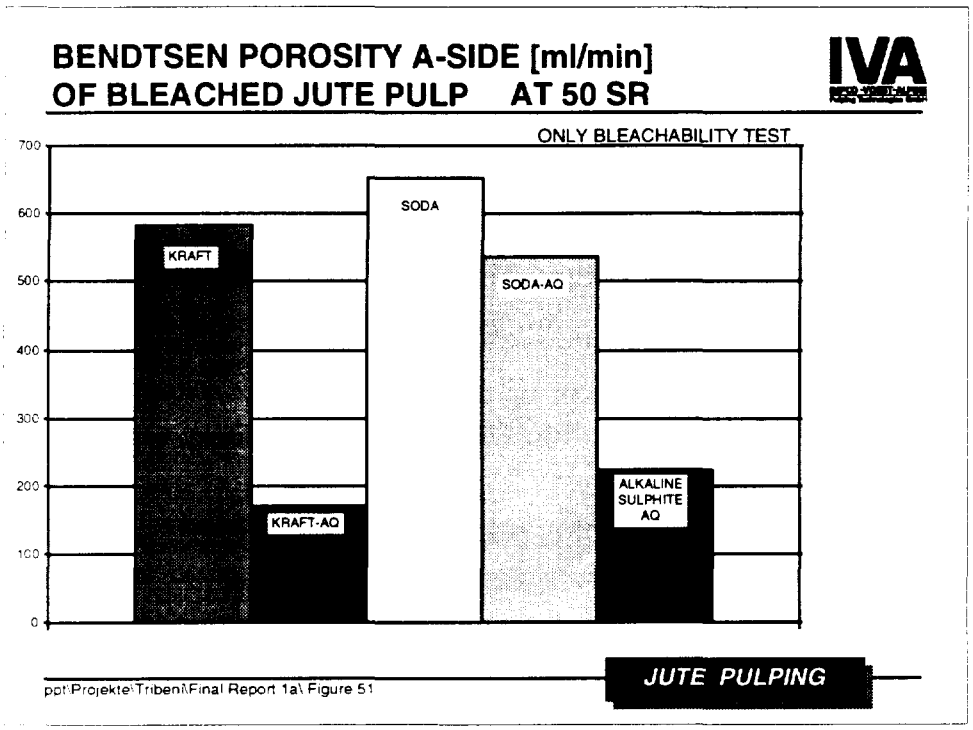

ZERO SPAN TENSILE [km]
OF BLEACHED JUTE PULP
IVA
ONLY BLEACHABILITY TEST
8.00
7.00
6.00
5.00
4.00
3.00
2.00
1.00
0.00
KRAFT
KRAFT-AQ
SODA
SODA-AQ
ALKALINE SULPHITE AQ
ppt\Projekte\Tribeni\Final Report 1a\ Figure 46
JUTE PULPING

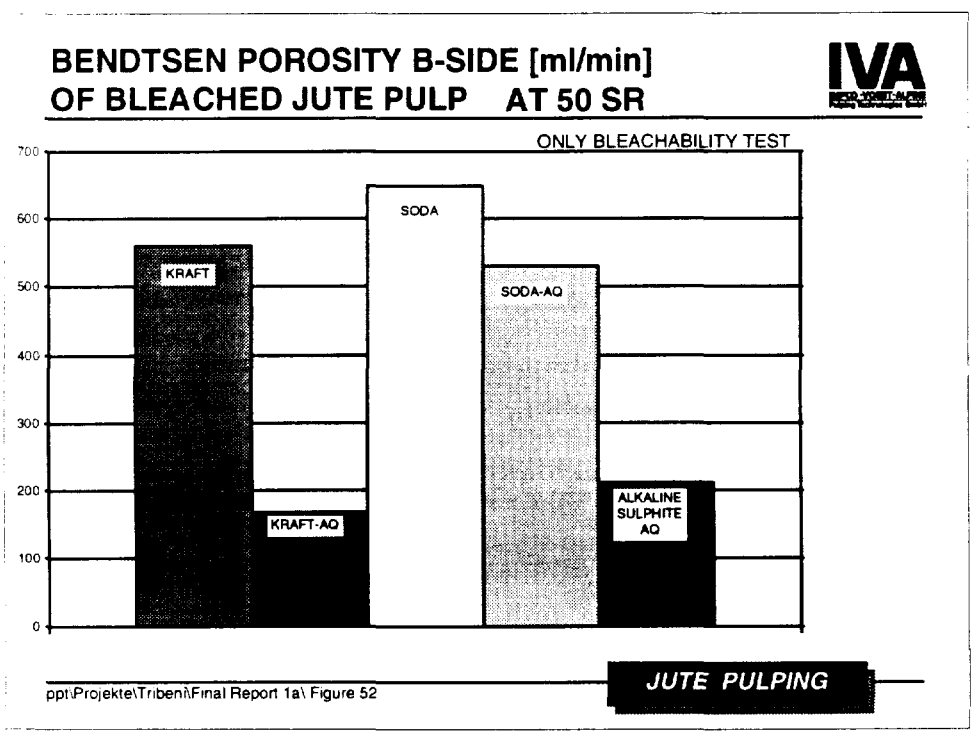

TENSILE INDEX [Nm/g]
OF BLEACHED JUTE PULP AT 50 SR
IVA
ONLY BLEACHABILITY TEST
80.00
70.00
60.00
50.00
40.00
30.00
20.00
10.00
0.00
KRAFT
KRAFT-AQ
SODA
SODA-AQ
ALKALINE SULPHITE AQ
ppt\Projekte\Tribeni\Final Report 1a\ Figure 47
JUTE PULPING

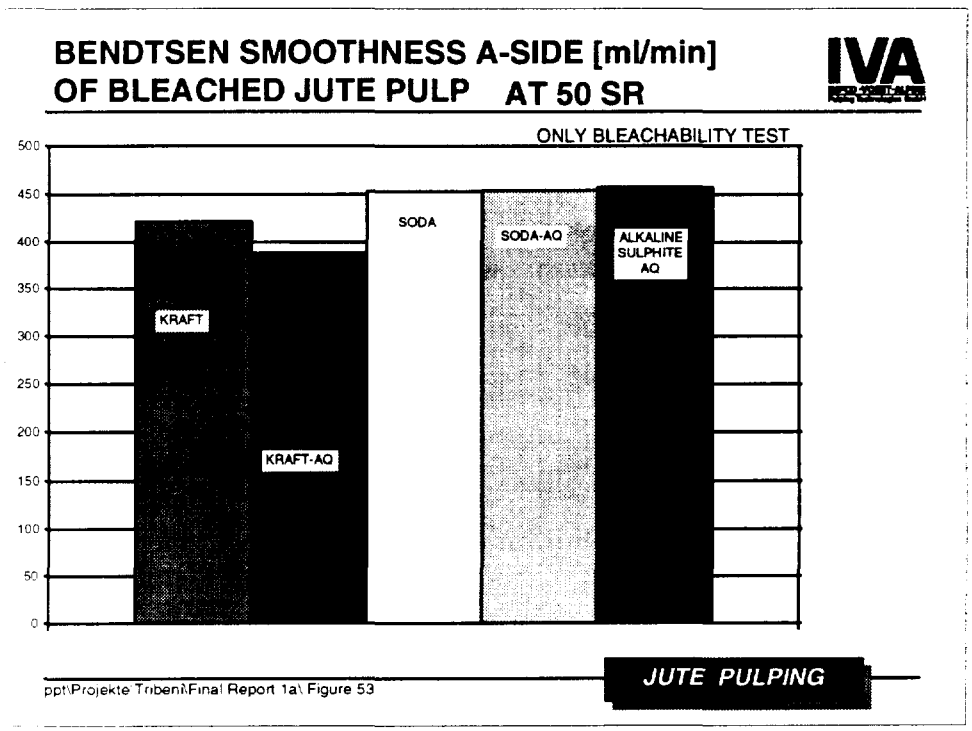

BURST INDEX [kPam2/g]
OF BLEACHED JUTE PULP AT 50 SR
IVA
ONLY BLEACHABILITY TEST
5.00
4.50
4.00
3.50
3.00
2.50
2.00
1.50
1.00
0.50
0.00
KRAFT
KRAFT-AQ
SODA
SODA-AQ
ALKALINE SULPHITE AQ
ppt\Projekte\Tribeni\Final Report 1a\ Figure 48
JUTE PULPING

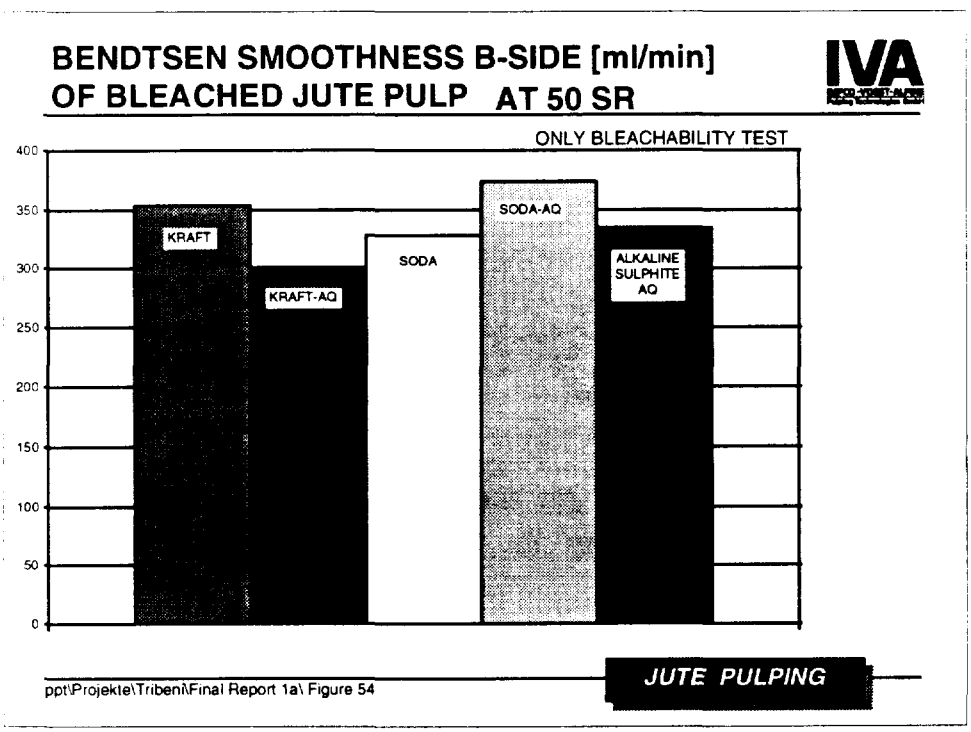

TEAR INDEX [mNm2/g]
OF BLEACHED JUTE PULP AT 50 SR
IVA
ONLY BLEACHABILITY TEST
18.00
16.00
14.00
12.00
10.00
8.00
6.00
4.00
2.00
0.00
KRAFT
KRAFT-AQ
SODA
SODA-AQ
ALKALINE SULPHITE AQ
ppt\Projekte\Tribeni\Final Report 1a\ Figure 49
JUTE PULPING

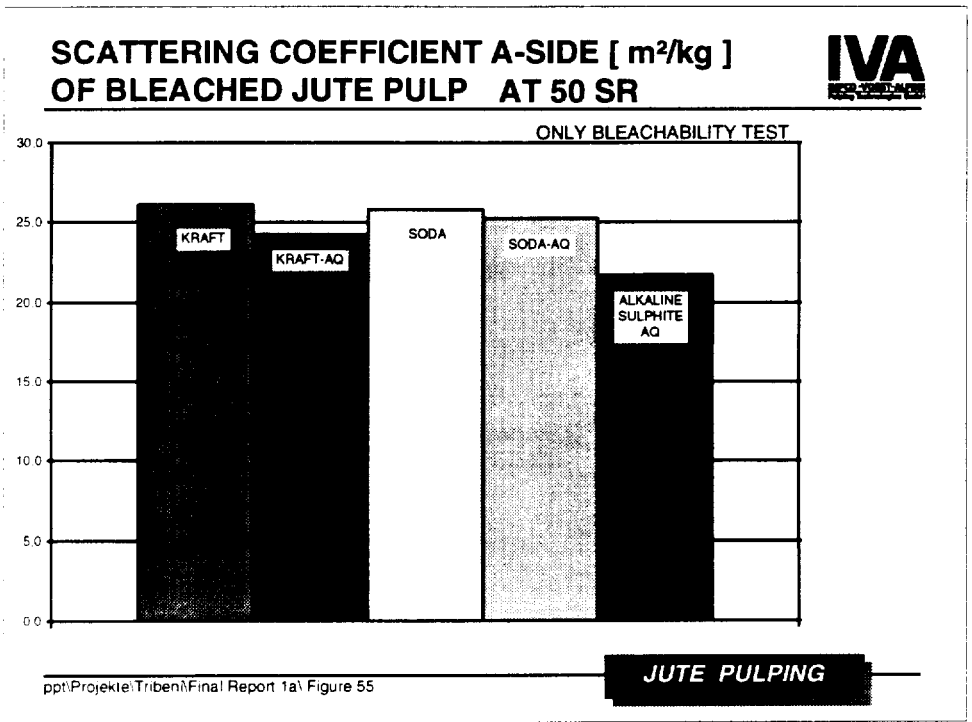

STRETCH [%]
OF BLEACHED JUTE PULP AT 50 SR
IVA
ONLY BLEACHABILITY TEST
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
KRAFT
KRAFT-AQ
SODA
SODA-AQ
ALKALINE SULPHITE AQ
ppt\Projekte\Tribeni\Final Report 1a\ Figure 50
JUTE PULPING

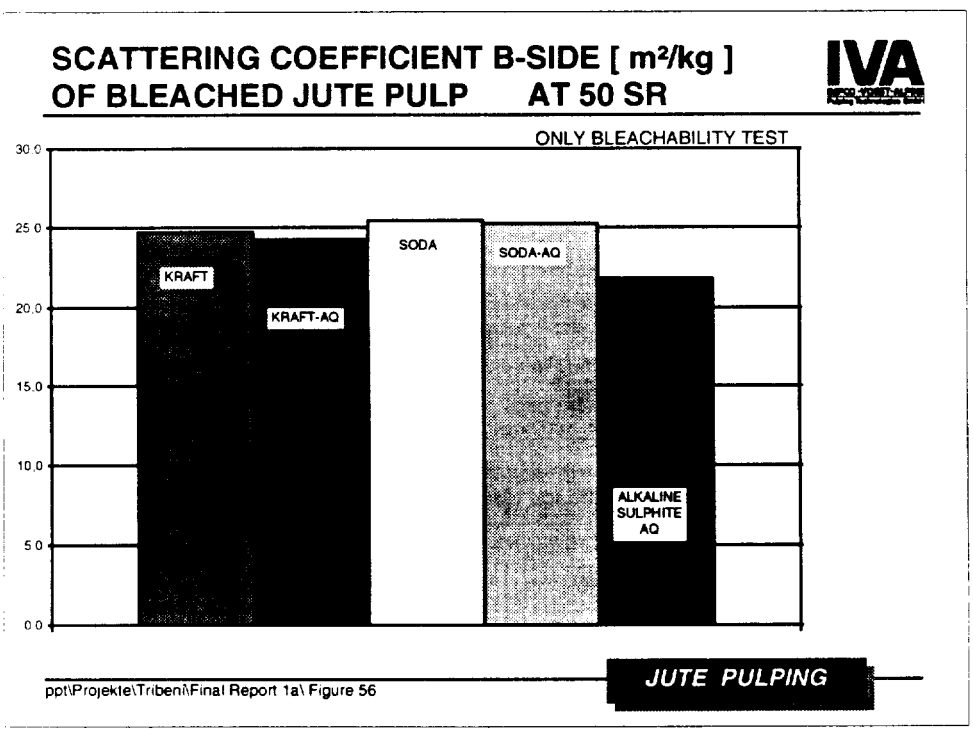

BENDTSEN POROSITY A-SIDE [ml/min]
OF BLEACHED JUTE PULP AT 50 SR
IVA
ONLY BLEACHABILITY TEST
700
600
500
400
300
200
100
0
KRAFT
KRAFT-AQ
SODA
SODA-AQ
ALKALINE SULPHITE AQ
ppt\Projekte\Triben\Final Report 1a\ Figure 51
JUTE PULPING

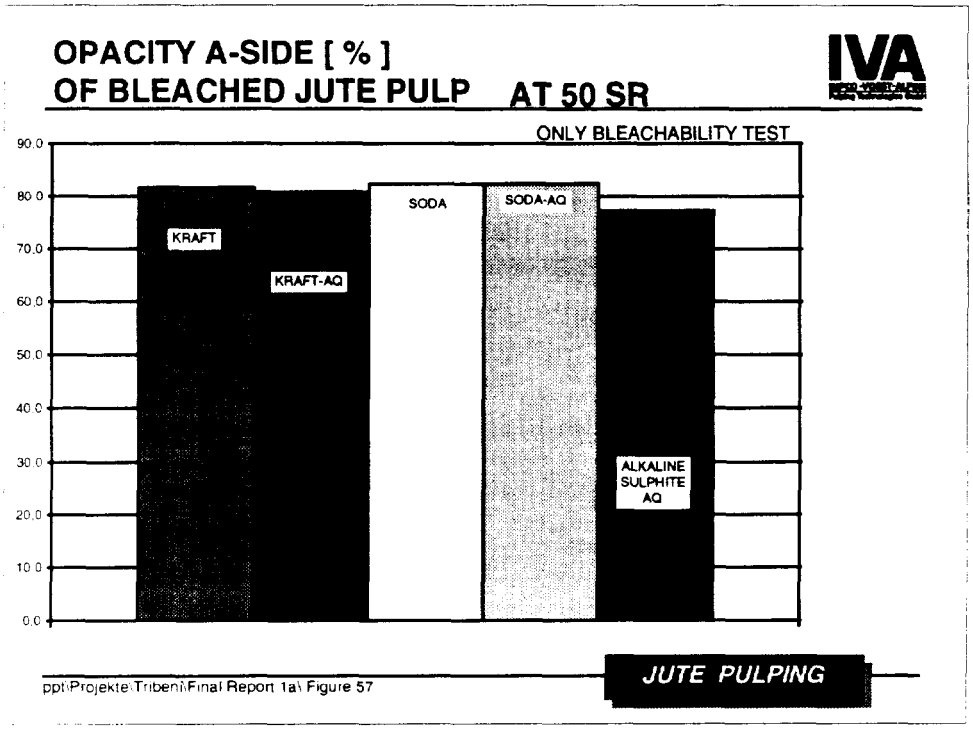

BENDTSEN POROSITY B-SIDE [ml/min]
OF BLEACHED JUTE PULP AT 50 SR
IVA
ONLY BLEACHABILITY TEST
700
600
500
400
300
200
100
0
KRAFT
KRAFT-AQ
SODA
SODA-AQ
ALKALINE SULPHITE AQ
ppt\Projekte\Triben\Final Report 1a\ Figure 52
JUTE PULPING

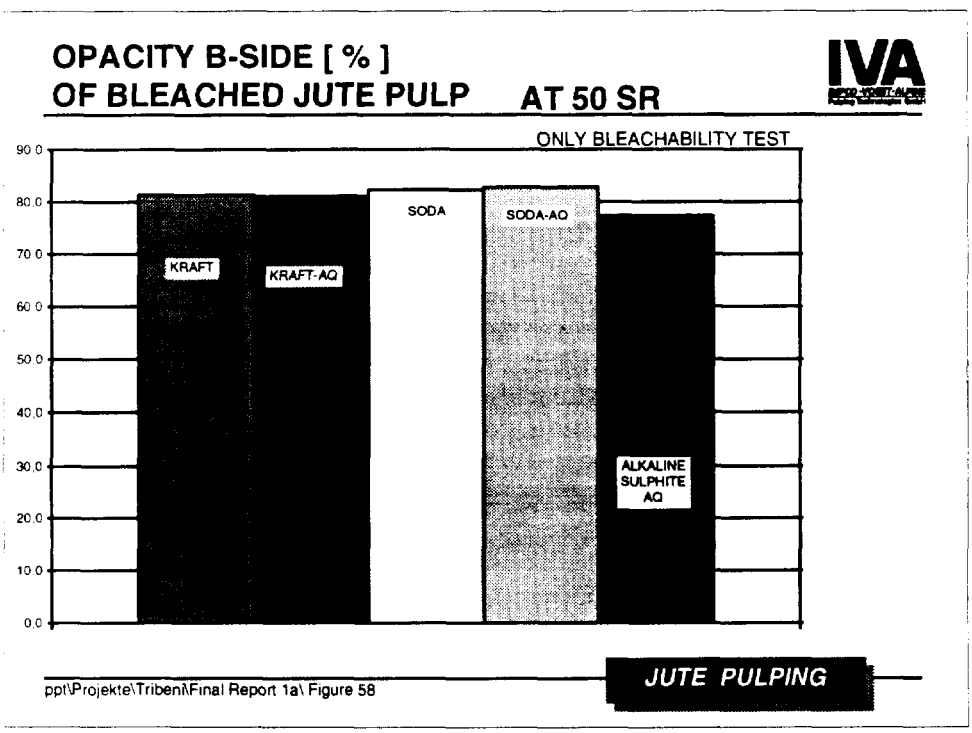

BENDTSEN SMOOTHNESS A-SIDE [ml/min]
OF BLEACHED JUTE PULP AT 50 SR
IVA
ONLY BLEACHABILITY TEST
500
450
400
350
300
250
200
150
100
50
0
KRAFT
KRAFT-AQ
SODA
SODA-AQ
ALKALINE SULPHITE AQ
ppt\Projekte Triben\Final Report 1a\ Figure 53
JUTE PULPING

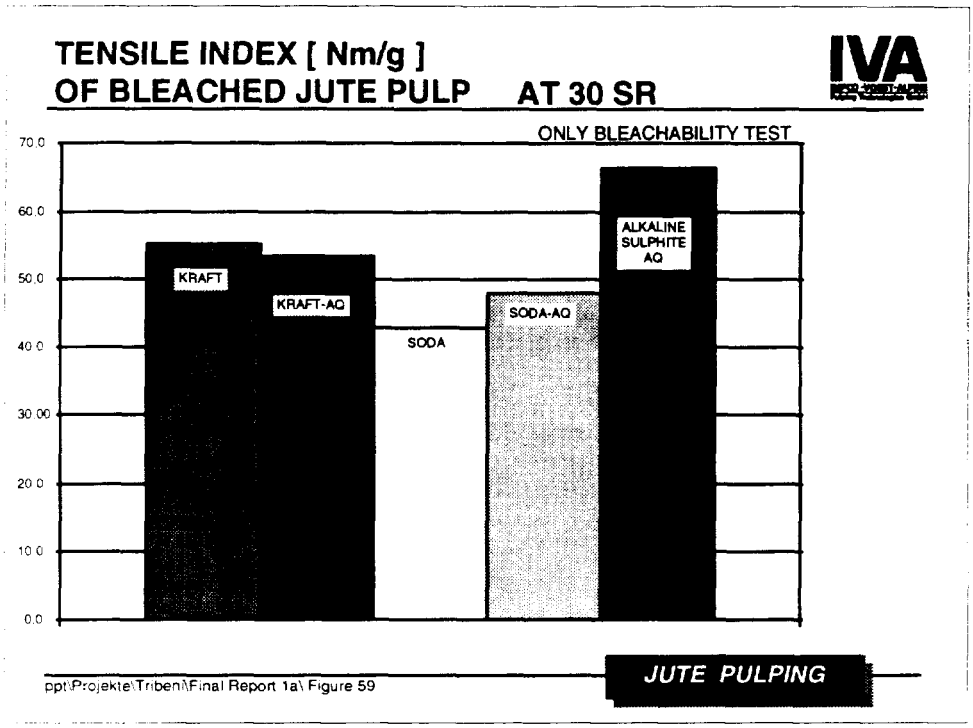

BENDTSEN SMOOTHNESS B-SIDE [ml/min]
OF BLEACHED JUTE PULP AT 50 SR
IVA
ONLY BLEACHABILITY TEST
400
350
300
250
200
150
100
50
0
KRAFT
KRAFT-AQ
SODA
SODA-AQ
ALKALINE SULPHITE AQ
ppt\Projekte\Triben\Final Report 1a\ Figure 54
JUTE PULPING

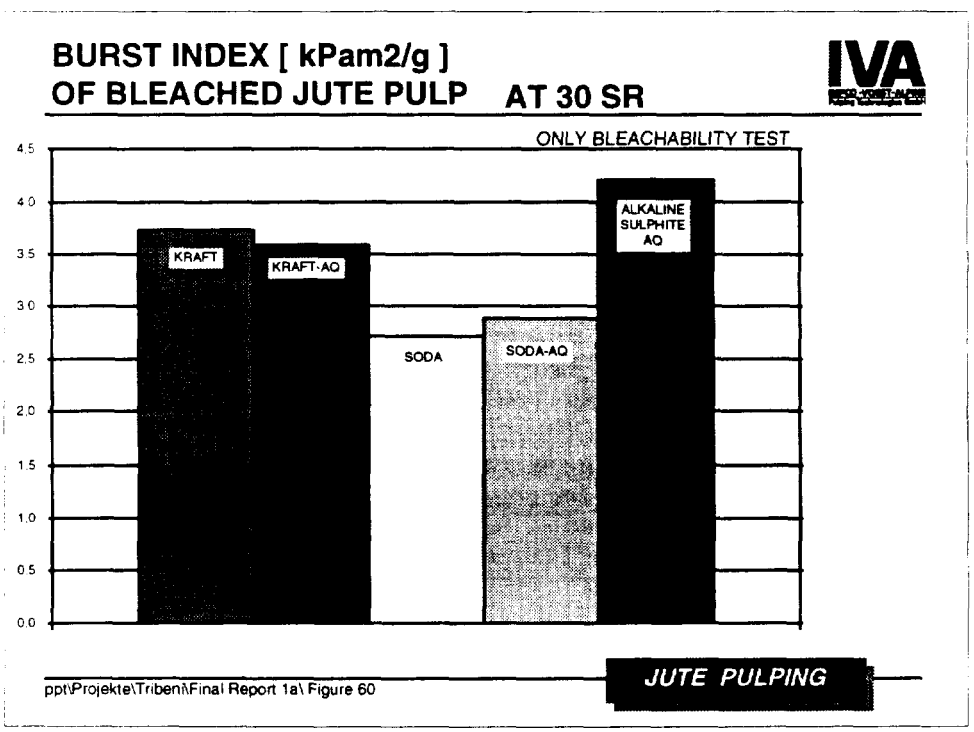

SCATTERING COEFFICIENT A-SIDE [m²/kg]
OF BLEACHED JUTE PULP AT 50 SR
IVA
ONLY BLEACHABILITY TEST
30.0
25.0
20.0
15.0
10.0
5.0
0.0
KRAFT
KRAFT-AQ
SODA
SODA-AQ
ALKALINE SULPHITE AQ
ppt\Projekte\Tribeni\Final Report 1a\ Figure 55
JUTE PULPING

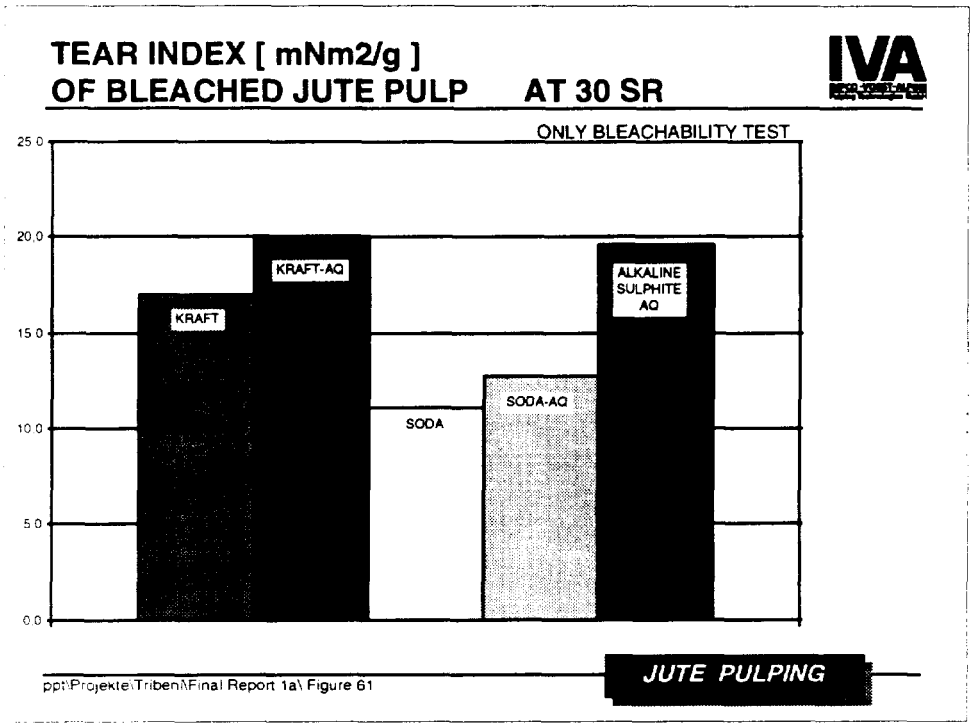

SCATTERING COEFFICIENT B-SIDE [m²/kg]
OF BLEACHED JUTE PULP AT 50 SR
IVA
ONLY BLEACHABILITY TEST
30.0
25.0
20.0
15.0
10.0
5.0
0.0
KRAFT
KRAFT-AQ
SODA
SODA-AQ
ALKALINE SULPHITE AQ
ppt\Projekte\Tribeni\Final Report 1a\ Figure 56
JUTE PULPING

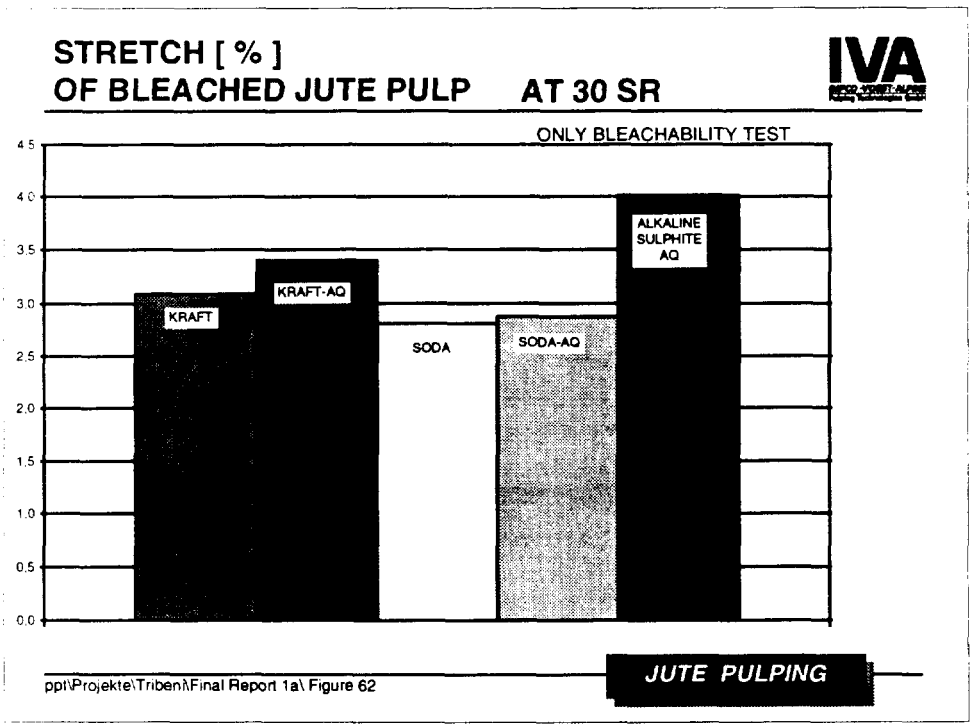

OPACITY A-SIDE [%]
OF BLEACHED JUTE PULP AT 50 SR
IVA
ONLY BLEACHABILITY TEST
90.0
80.0
70.0
60.0
50.0
40.0
30.0
20.0
10.0
0.0
KRAFT
KRAFT-AQ
SODA
SODA-AQ
ALKALINE SULPHITE AQ
ppt\Projekte\Tribeni\Final Report 1a\ Figure 57
JUTE PULPING

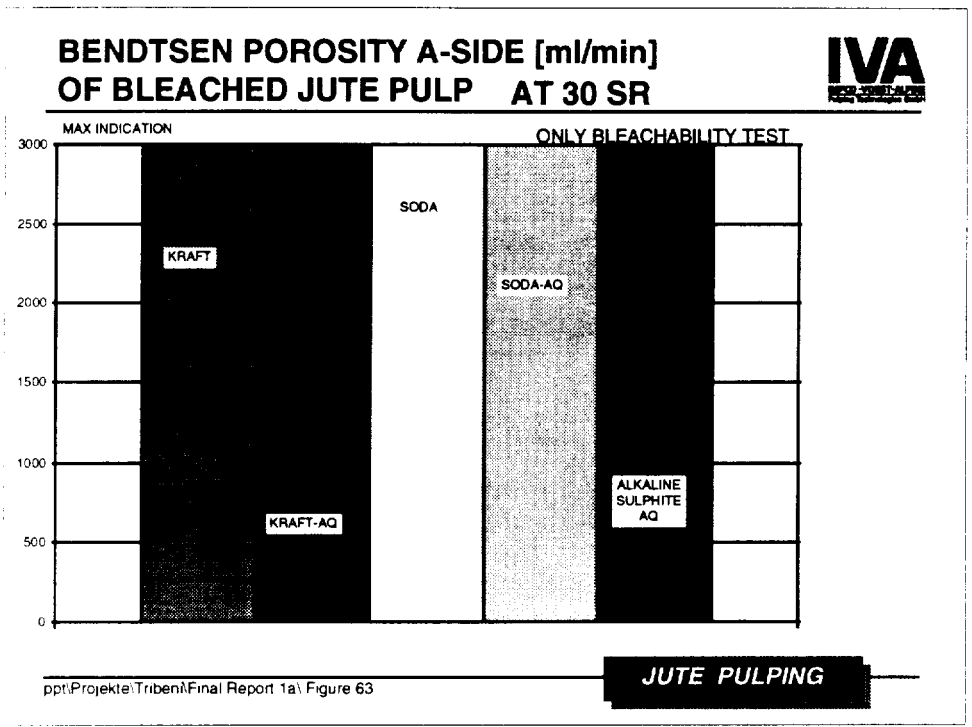

OPACITY B-SIDE [%]
OF BLEACHED JUTE PULP AT 50 SR
IVA
ONLY BLEACHABILITY TEST
90.0
80.0
70.0
60.0
50.0
40.0
30.0
20.0
10.0
0.0
KRAFT
KRAFT-AQ
SODA
SODA-AQ
ALKALINE SULPHITE AQ
ppt\Projekte\Tribeni\Final Report 1a\ Figure 58
JUTE PULPING

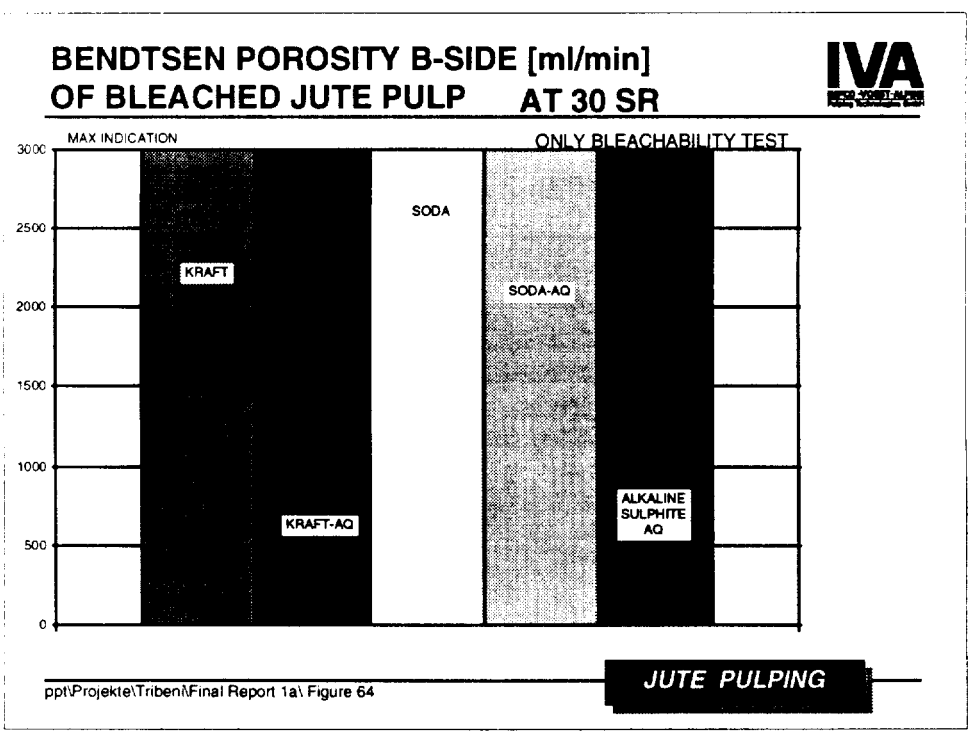

TENSILE INDEX [Nm/g]
OF BLEACHED JUTE PULP AT 30 SR
IVA
ONLY BLEACHABILITY TEST
70.0
60.0
50.0
40.0
30.00
20.0
10.0
0.0
KRAFT
KRAFT-AQ
SODA
SODA-AQ
ALKALINE SULPHITE AQ
ppt\Projekte\Triben\Final Report 1a\ Figure 59
JUTE PULPING

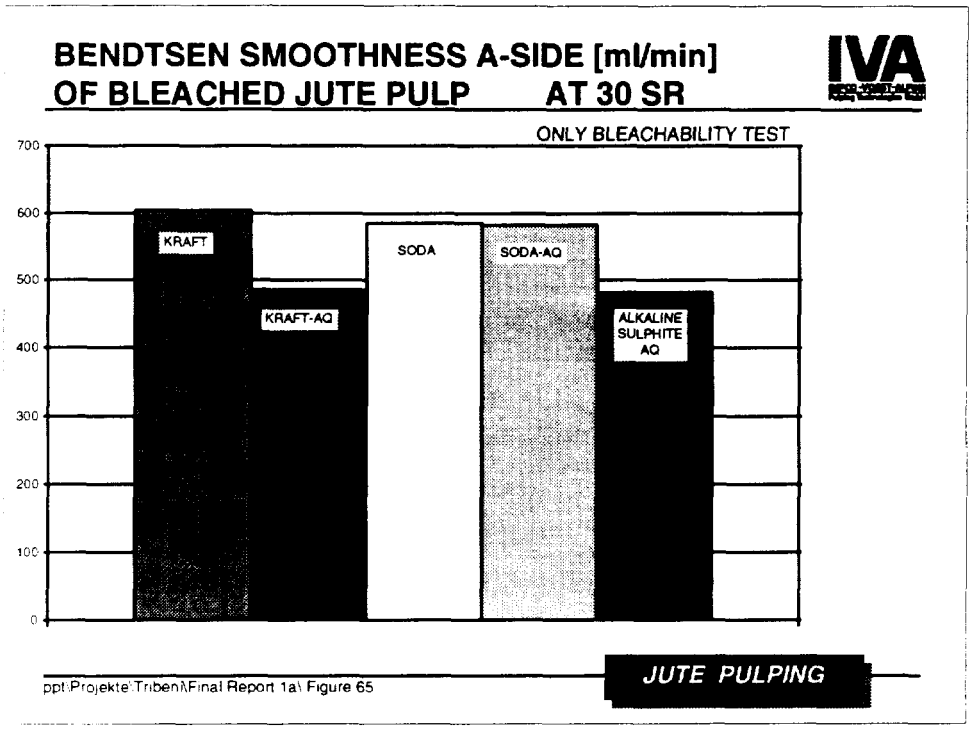

BURST INDEX [kPam2/g]
OF BLEACHED JUTE PULP AT 30 SR
IVA
ONLY BLEACHABILITY TEST
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
KRAFT
KRAFT-AQ
SODA
SODA-AQ
ALKALINE SULPHITE AQ
ppt\Projekte\Triben\Final Report 1a\ Figure 60
JUTE PULPING

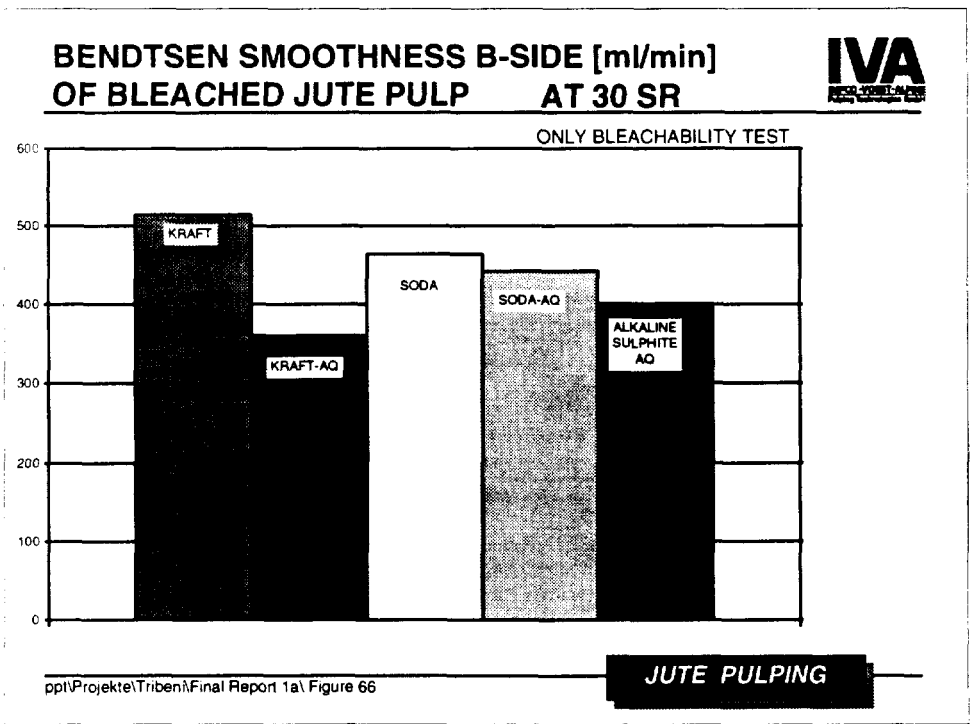

TEAR INDEX [mNm2/g]
OF BLEACHED JUTE PULP AT 30 SR
IVA
ONLY BLEACHABILITY TEST
25.0
20.0
15.0
10.0
5.0
0.0
KRAFT
KRAFT-AQ
SODA
SODA-AQ
ALKALINE SULPHITE AQ
ppt\Projekte\Triben\Final Report 1a\ Figure 61
JUTE PULPING

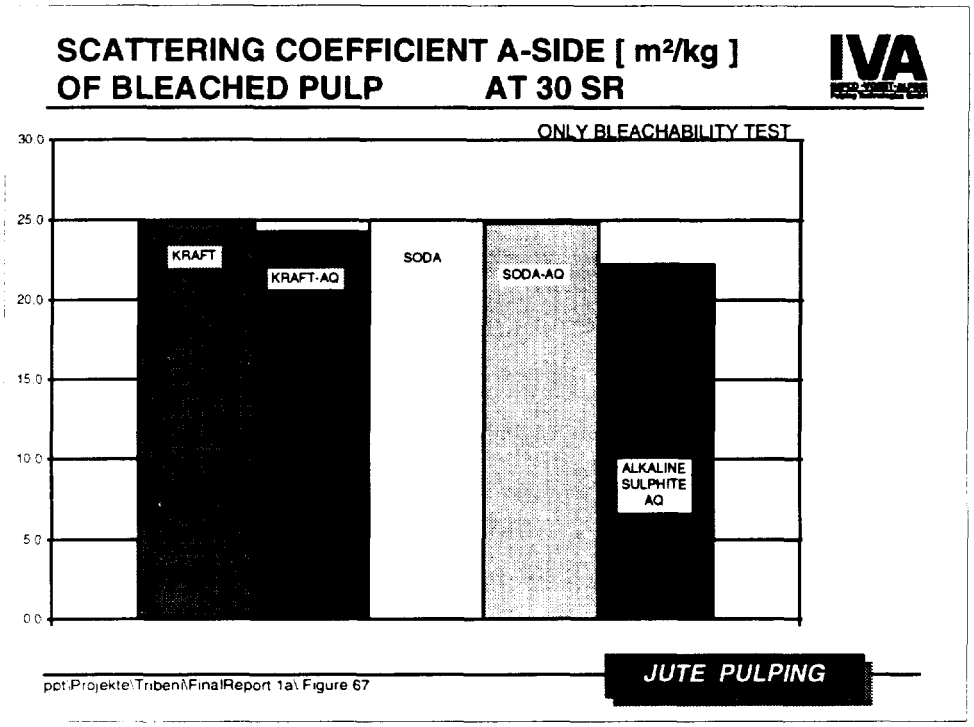

STRETCH [%]
OF BLEACHED JUTE PULP AT 30 SR
IVA
ONLY BLEACHABILITY TEST
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
KRAFT
KRAFT-AQ
SODA
SODA-AQ
ALKALINE SULPHITE AQ
ppt\Projekte\Triben\Final Report 1a\ Figure 62
JUTE PULPING

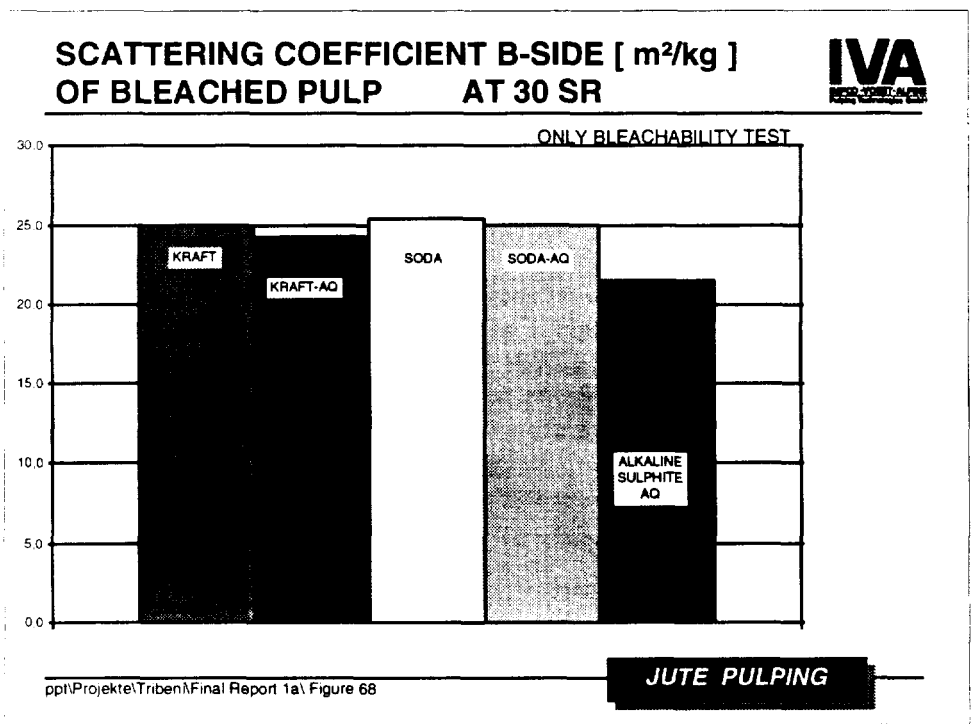

BENDTSEN POROSITY A-SIDE [ml/min]
OF BLEACHED JUTE PULP AT 30 SR
IVA
MAX INDICATION
ONLY BLEACHABILITY TEST
3000
2500
2000
1500
1000
500
0
KRAFT
KRAFT-AQ
SODA
SODA-AQ
ALKALINE SULPHITE AQ
ppt\Projekte\Triben\Final Report 1a\ Figure 63
JUTE PULPING

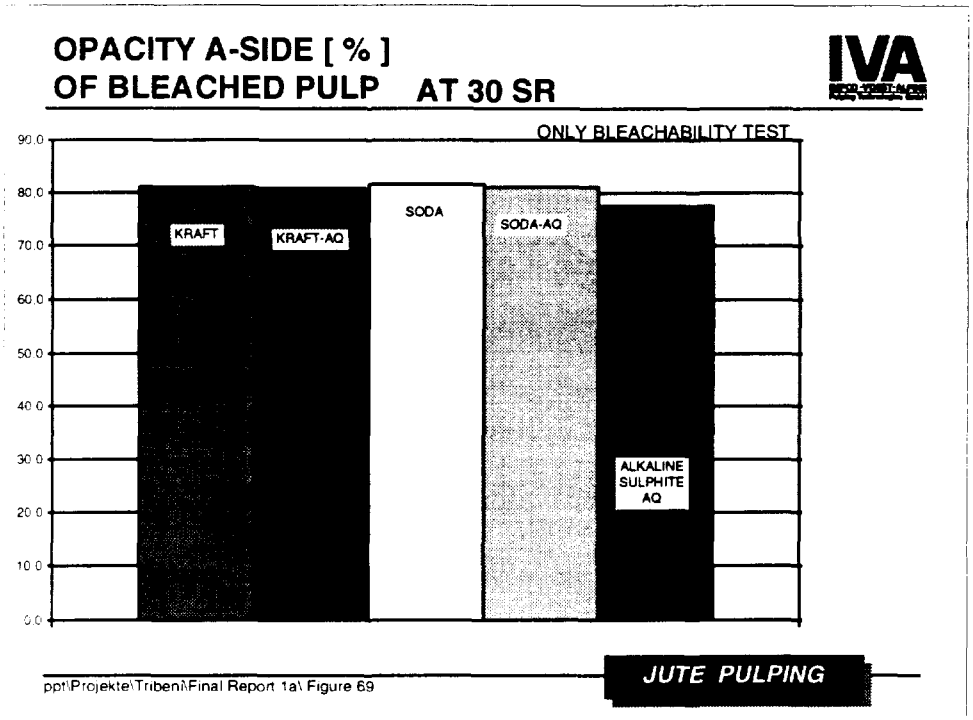

BENDTSEN POROSITY B-SIDE [ml/min]
OF BLEACHED JUTE PULP AT 30 SR
IVA
MAX INDICATION
ONLY BLEACHABILITY TEST
3000
2500
2000
1500
1000
500
0
KRAFT
KRAFT-AQ
SODA
SODA-AQ
ALKALINE SULPHITE AQ
ppt\Projekte\Triben\Final Report 1a\ Figure 64
JUTE PULPING

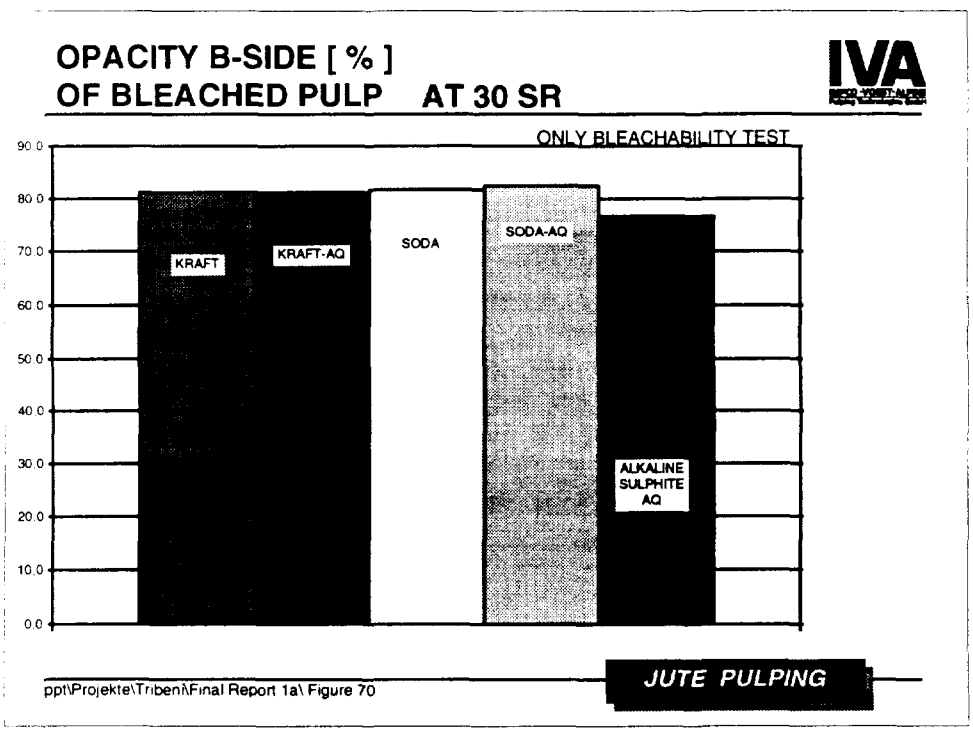

BENDTSEN SMOOTHNESS A-SIDE [ml/min]
OF BLEACHED JUTE PULP AT 30 SR
IVA
ONLY BLEACHABILITY TEST
700
600
500
400
300
200
100
0
KRAFT
KRAFT-AQ
SODA
SODA-AQ
ALKALINE SULPHITE AQ
ppt\Projekte\Triben\Final Report 1a\ Figure 65
JUTE PULPING

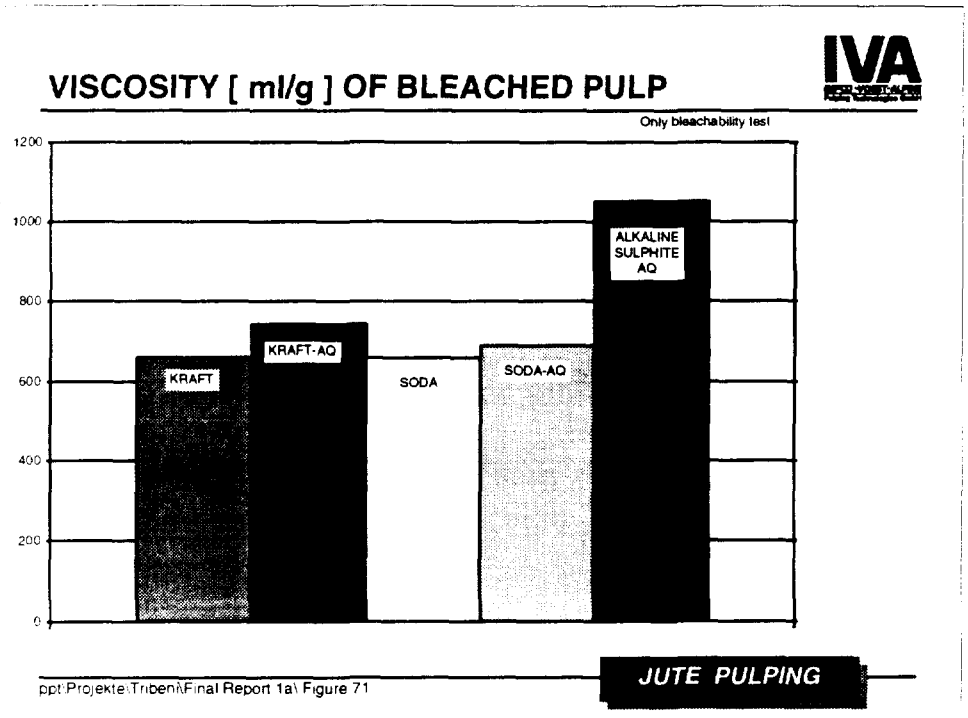

BENDTSEN SMOOTHNESS B-SIDE [ml/min]
OF BLEACHED JUTE PULP AT 30 SR
IVA
ONLY BLEACHABILITY TEST
600
500
400
300
200
100
0
KRAFT
KRAFT-AQ
SODA
SODA-AQ
ALKALINE SULPHITE AQ
ppt\Projekte\Triben\Final Report 1a\ Figure 66
JUTE PULPING


SCATTERING COEFFICIENT A-SIDE [m²/kg]
OF BLEACHED PULP AT 30 SR
IVA
ONLY BLEACHABILITY TEST
30.0
25.0
20.0
15.0
10.0
5.0
0.0
KRAFT
KRAFT-AQ
SODA
SODA-AQ
ALKALINE SULPHITE AQ
ppt\Projekte\Triben\FinalReport 1a\ Figure 67
JUTE PULPING

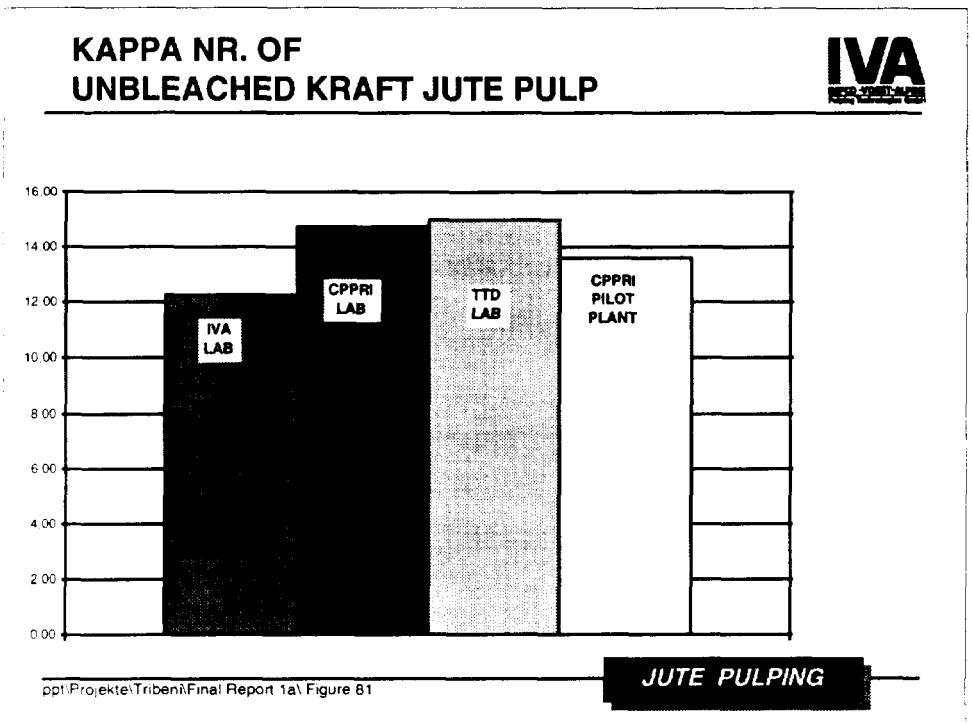

SCATTERING COEFFICIENT B-SIDE [m²/kg]
OF BLEACHED PULP AT 30 SR
IVA
ONLY BLEACHABILITY TEST
30.0
25.0
20.0
15.0
10.0
5.0
0.0
KRAFT
KRAFT-AQ
SODA
SODA-AQ
ALKALINE SULPHITE AQ
ppt\Projekte\Triben\Final Report 1a\ Figure 68
JUTE PULPING

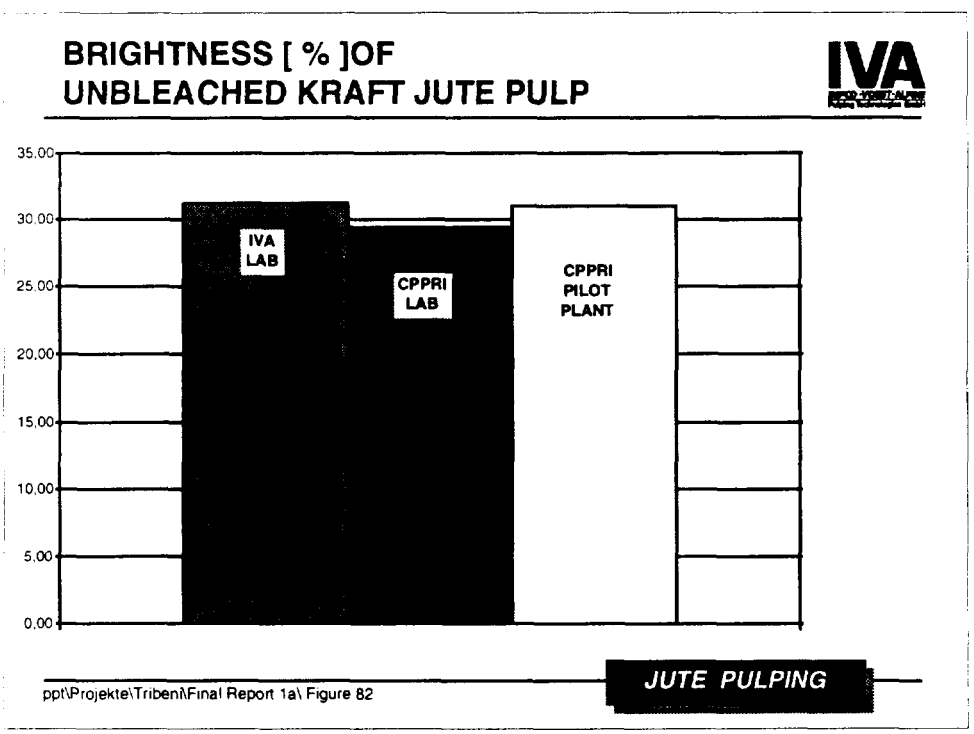

OPACITY A-SIDE [%]
OF BLEACHED PULP AT 30 SR
IVA
ONLY BLEACHABILITY TEST
90.0
80.0
70.0
60.0
50.0
40.0
30.0
20.0
10.0
0.0
KRAFT
KRAFT-AQ
SODA
SODA-AQ
ALKALINE SULPHITE AQ
ppt\Projekte\Triben\Final Report 1a\ Figure 69
JUTE PULPING

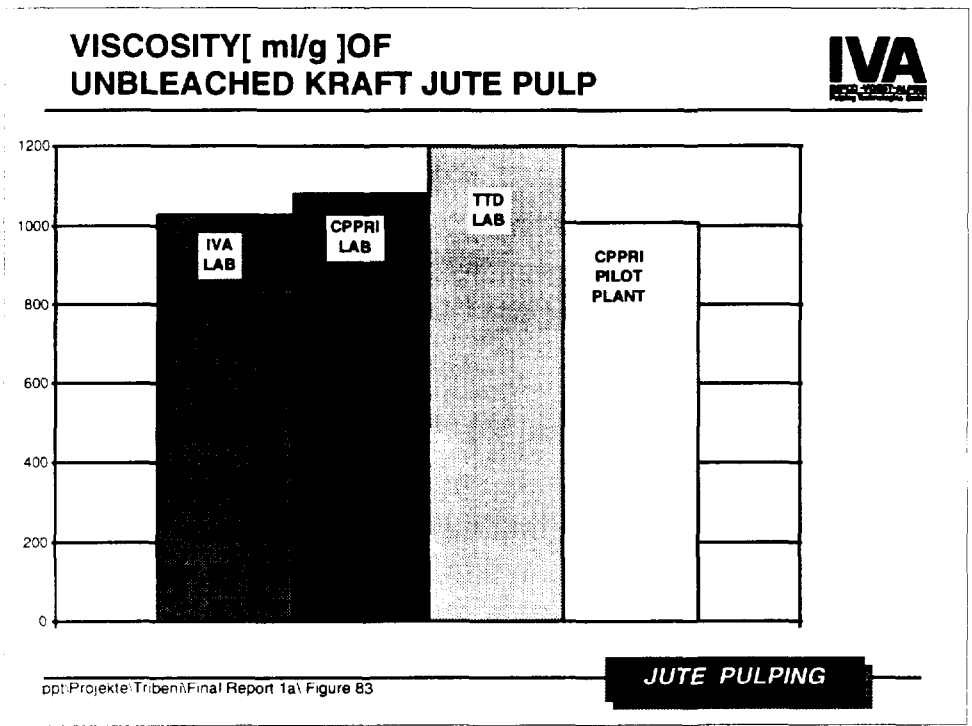

OPACITY B-SIDE [%]
OF BLEACHED PULP AT 30 SR
IVA
ONLY BLEACHABILITY TEST
90.0
80.0
70.0
60.0
50.0
40.0
30.0
20.0
10.0
0.0
KRAFT
KRAFT-AQ
SODA
SODA-AQ
ALKALINE SULPHITE AQ
ppt\Projekte\Triben\Final Report 1a\ Figure 70
JUTE PULPING

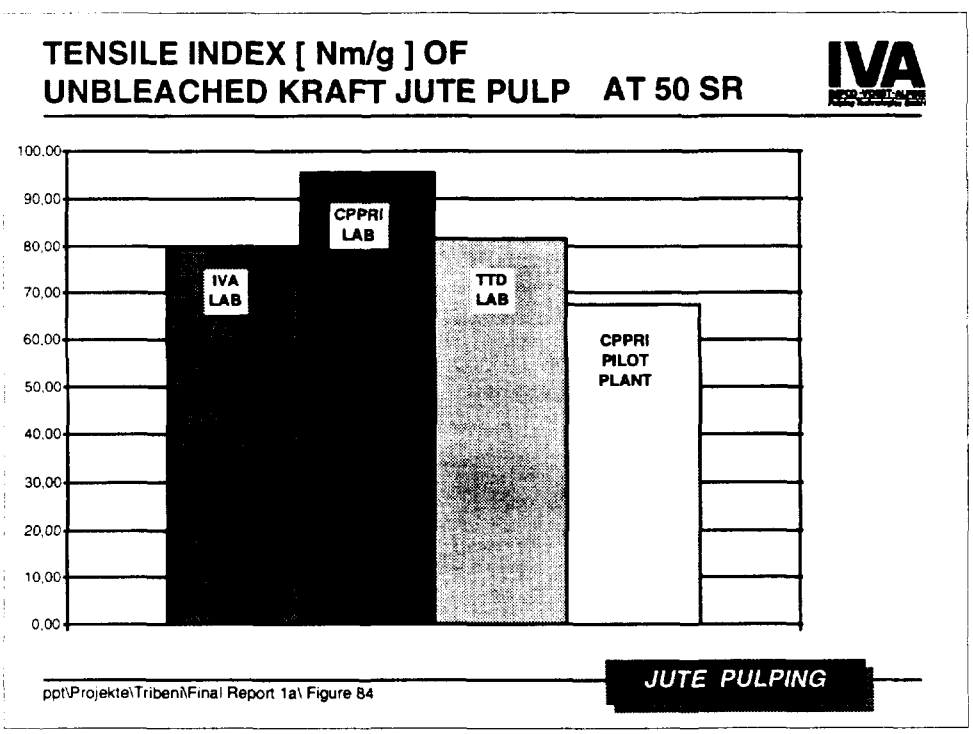

VISCOSITY [ml/g] OF BLEACHED PULP
IVA
Only bleachability test
1200
1000
800
600
400
200
0
KRAFT
KRAFT-AQ
SODA
SODA-AQ
ALKALINE SULPHITE AQ
ppt:Projekte\Tribeni\Final Report 1a\ Figure 71
JUTE PULPING

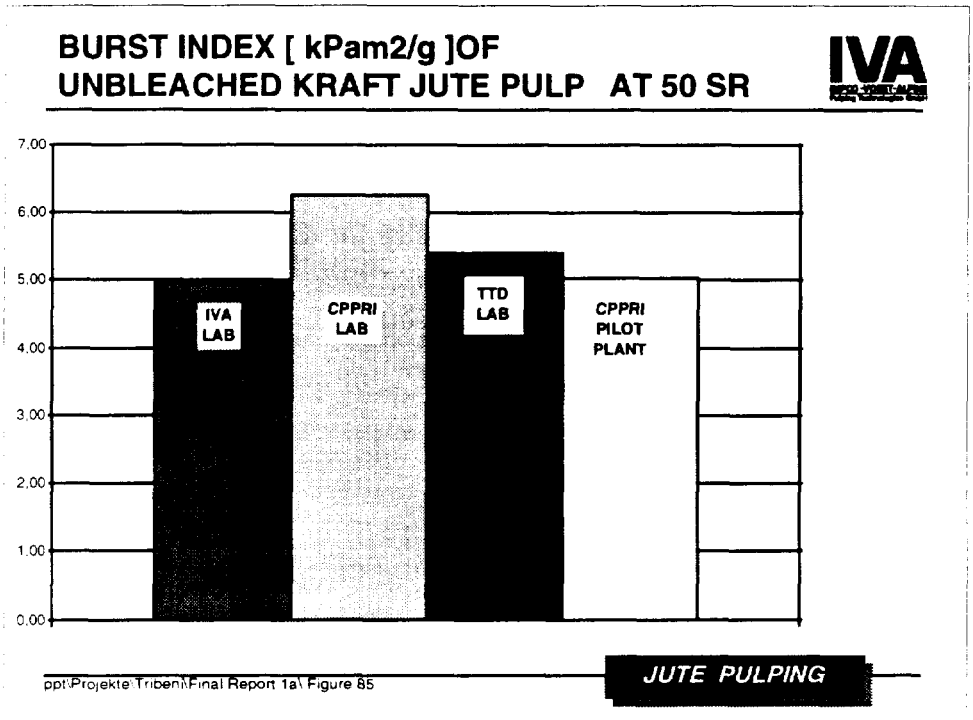
11.3 Bench scale and pilot plant pulping tests at CPPRI

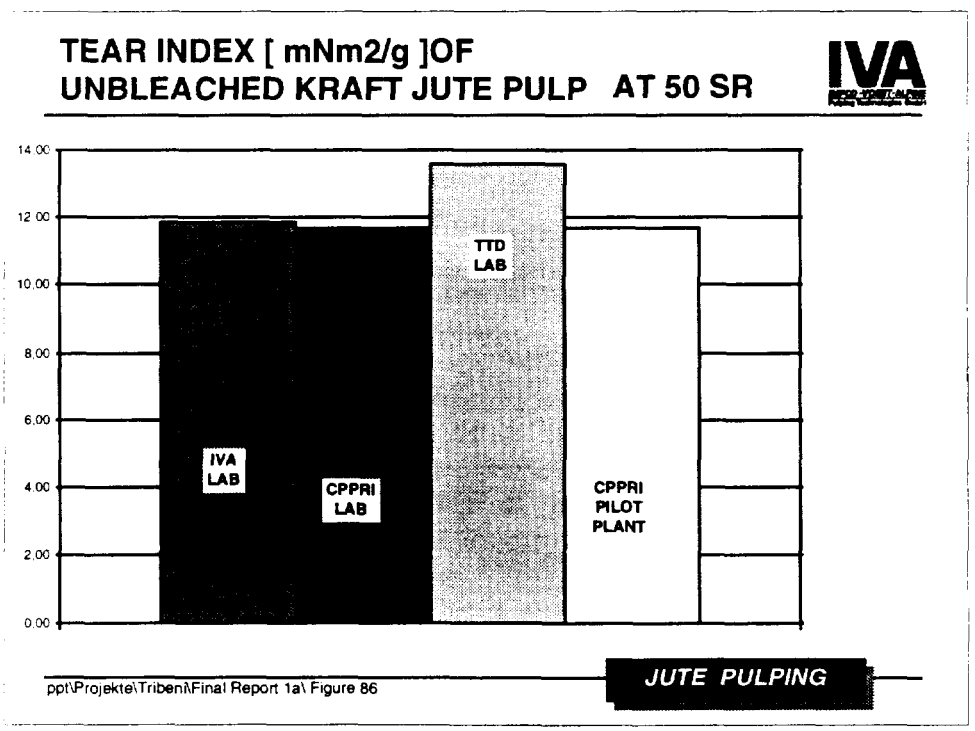

KAPPA NR. OF
UNBLEACHED KRAFT JUTE PULP
IVA
16.00
14.00
12.00
10.00
8.00
6.00
4.00
2.00
0.00
IVA LAB
CPPRI LAB
TTD LAB
CPPRI PILOT PLANT
ppt\Projekte\Triben\Final Report 1a\ Figure 81
JUTE PULPING

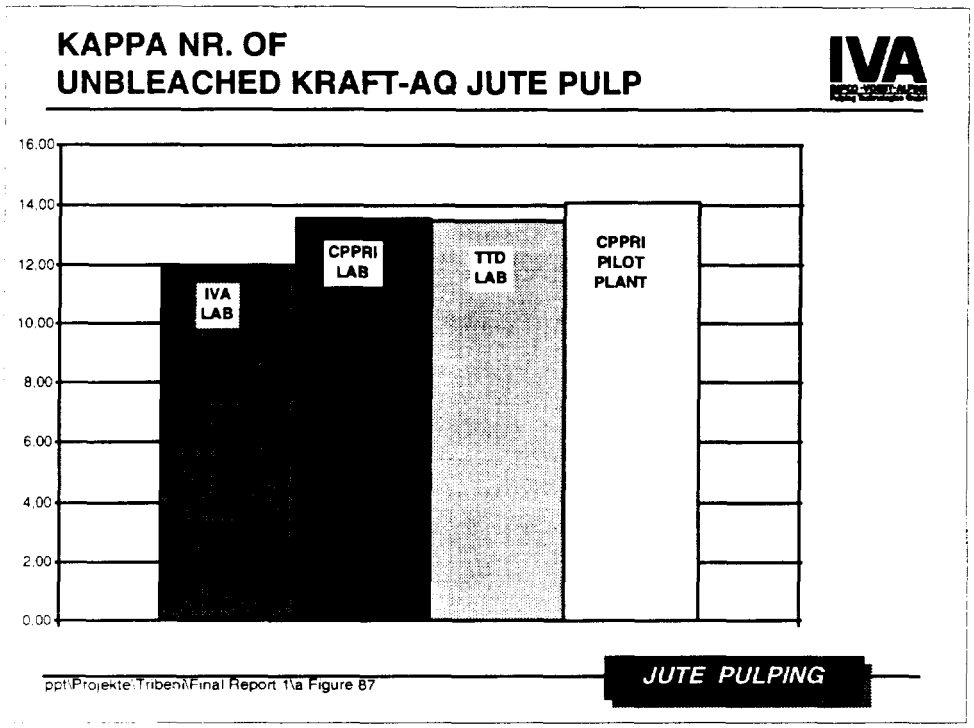

BRIGHTNESS [%]OF
UNBLEACHED KRAFT JUTE PULP
IVA
35.00
30.00
25.00
20.00
15.00
10.00
5.00
0.00
IVA LAB
CPPRI LAB
CPPRI PILOT PLANT
ppt\Projekte\Triben\Final Report 1a\ Figure 82
JUTE PULPING

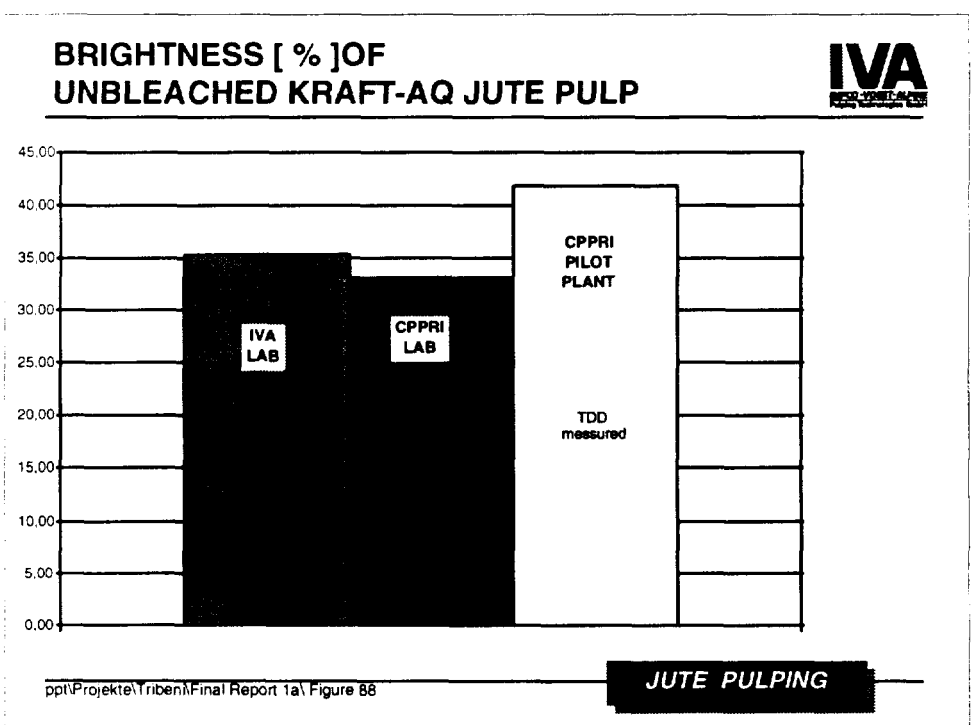

VISCOSITY[ml/g]OF
UNBLEACHED KRAFT JUTE PULP
IVA
1200
1000
800
600
400
200
0
IVA LAB
CPPRI LAB
TTD LAB
CPPRI PILOT PLANT
ppt\Projekte\Triben\\Final Report 1a\ Figure 83
JUTE PULPING

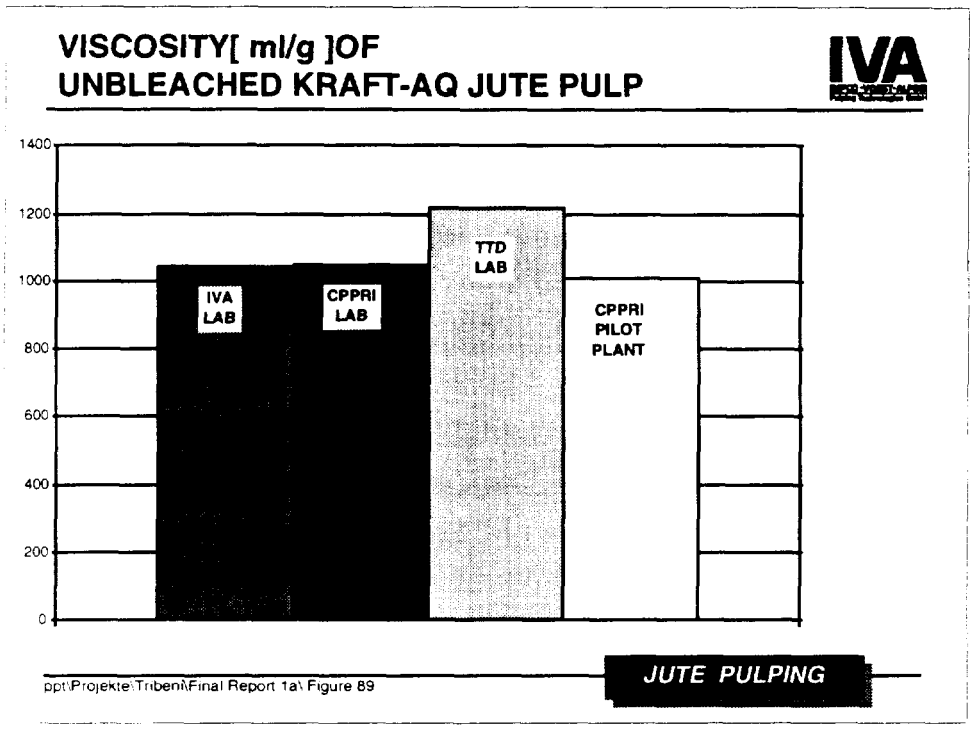

TENSILE INDEX [Nm/g] OF
UNBLEACHED KRAFT JUTE PULP AT 50 SR
IVA
100,00
90,00
80,00
70,00
60,00
50,00
40,00
30,00
20,00
10,00
0,00
IVA LAB
CPPRI LAB
TTD LAB
CPPRI PILOT PLANT
ppt\Projekte\Triben\\Final Report 1a\ Figure 84
JUTE PULPING

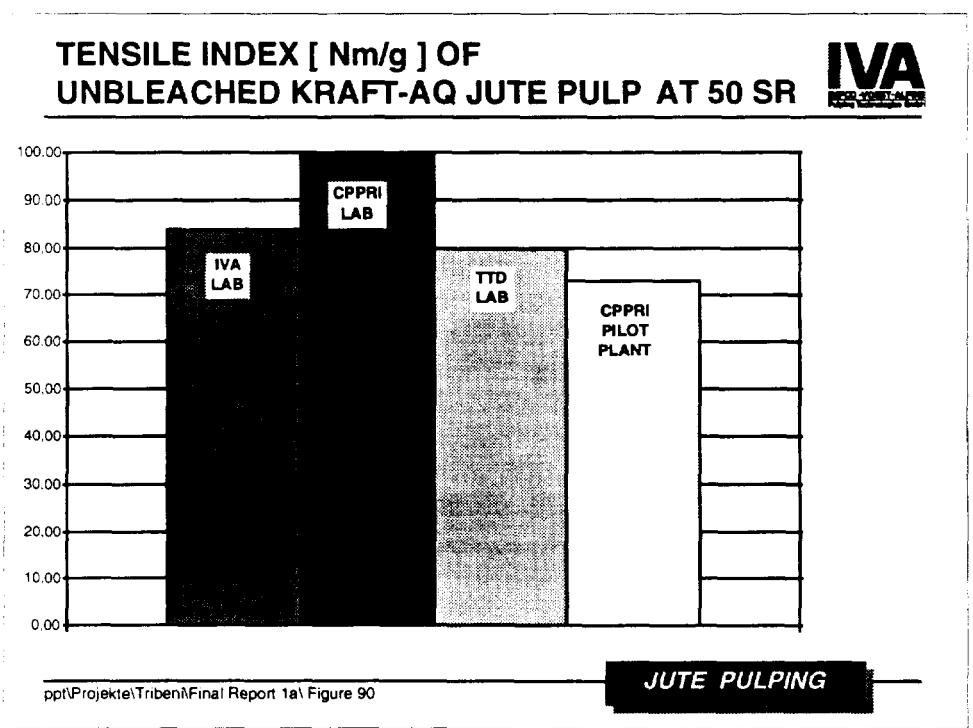

BURST INDEX [kPam2/g]OF
UNBLEACHED KRAFT JUTE PULP AT 50 SR
IVA
7.00
6.00
5.00
4.00
3.00
2.00
1.00
0.00
IVA LAB
CPPRI LAB
TTD LAB
CPPRI PILOT PLANT
ppt\Projekte\Triben\Final Report 1a\ Figure 85
JUTE PULPING

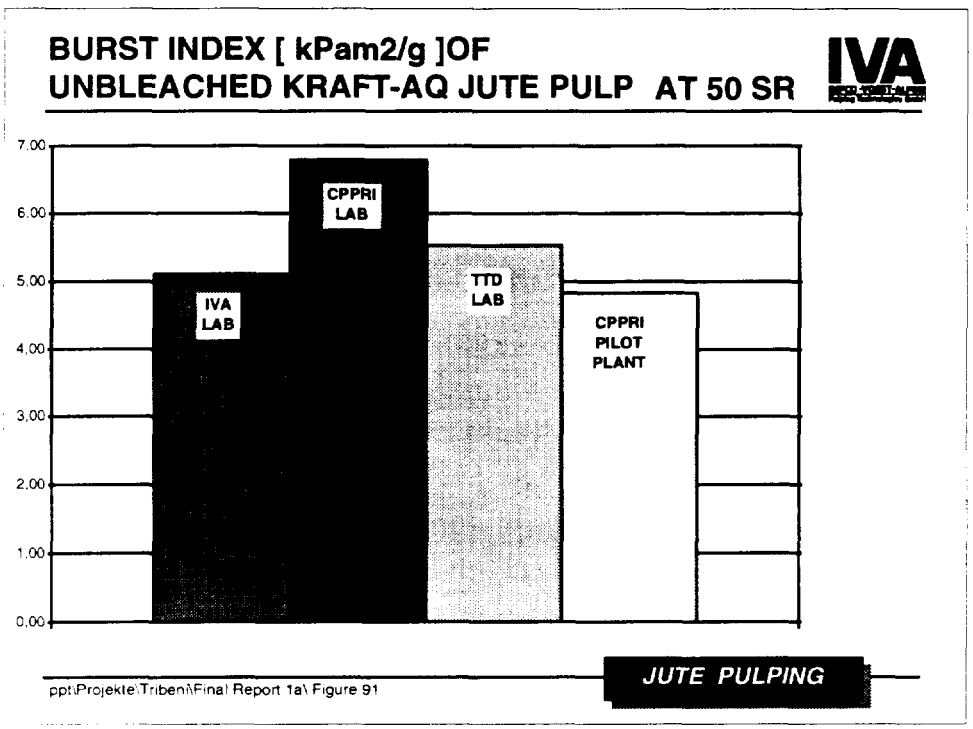

TEAR INDEX [mNm2/g]OF
UNBLEACHED KRAFT JUTE PULP AT 50 SR
IVA
14.00
12.00
10.00
8.00
6.00
4.00
2.00
0.00
IVA LAB
CPPRI LAB
TTD LAB
CPPRI PILOT PLANT
ppt\Projekte\Triben\Final Report 1a\ Figure 86
JUTE PULPING

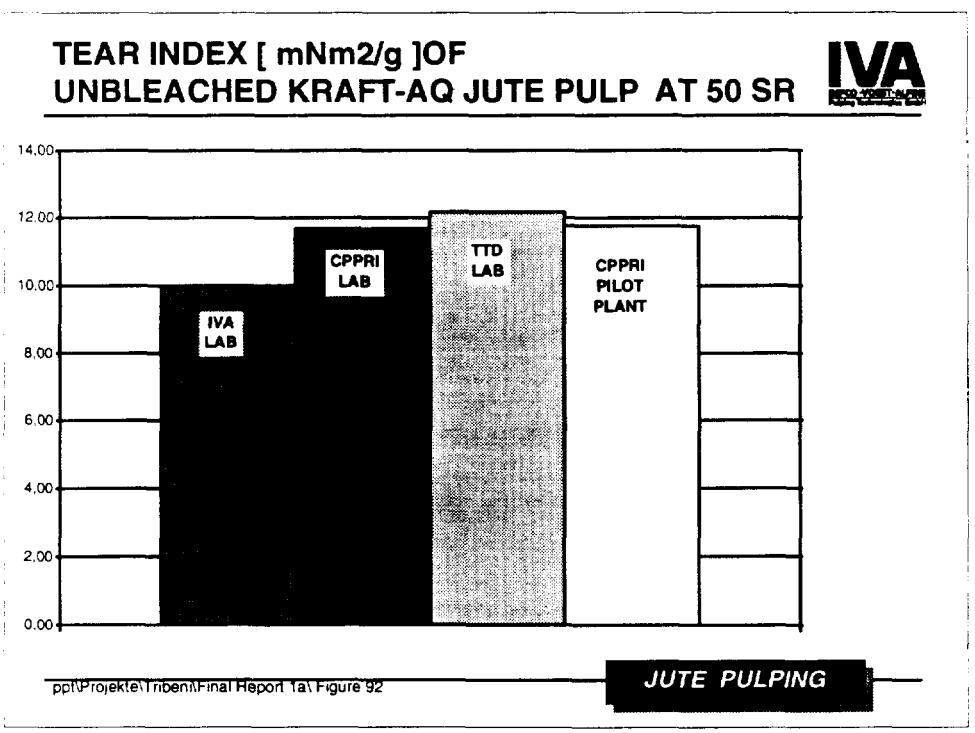

KAPPA NR. OF
UNBLEACHED KRAFT-AQ JUTE PULP
IVA
16.00
14.00
12.00
10.00
8.00
6.00
4.00
2.00
0.00
IVA LAB
CPPRI LAB
TTD LAB
CPPRI PILOT PLANT
ppt\Projekte\Triben\Final Report 1\a Figure 87
JUTE PULPING


BRIGHTNESS [%]OF
UNBLEACHED KRAFT-AQ JUTE PULP
IVA
45.00
40.00
35.00
30.00
25.00
20.00
15.00
10.00
5.00
0.00
IVA LAB
CPPRI LAB
CPPRI PILOT PLANT
TDD messured
ppt\Projekte\Triben\Final Report 1a\ Figure 88
JUTE PULPING

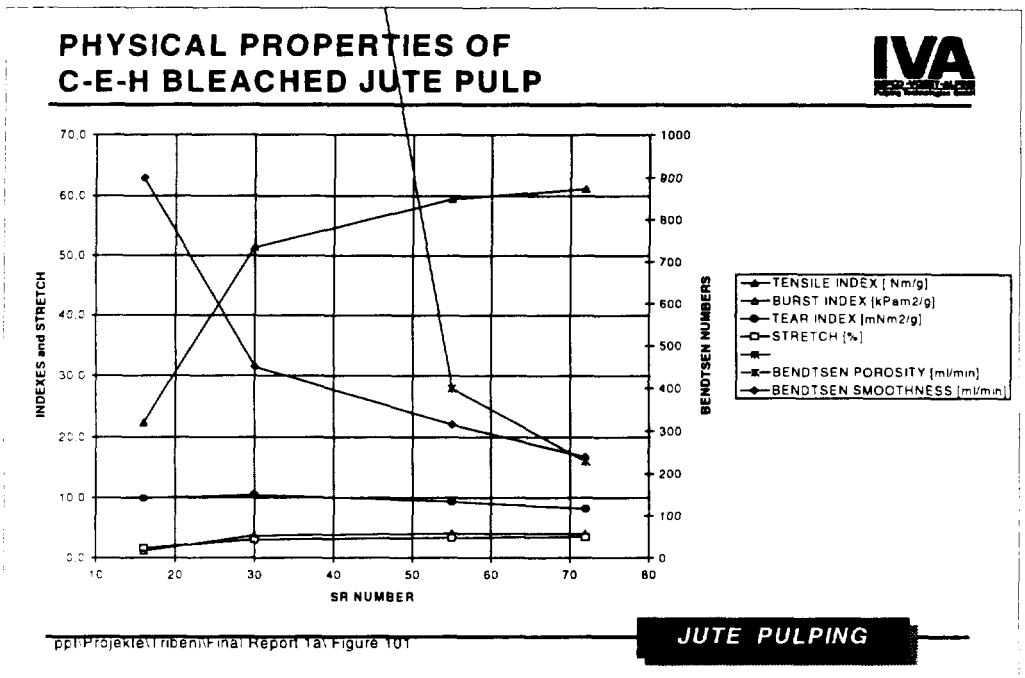

VISCOSITY[ml/g]OF
UNBLEACHED KRAFT-AQ JUTE PULP
IVA
1400
1200
1000
800
600
400
200
0
IVA LAB
CPPRI LAB
TTD LAB
CPPRI PILOT PLANT
ppt\Projekte\Triben\Final Report 1a\ Figure 89
JUTE PULPING

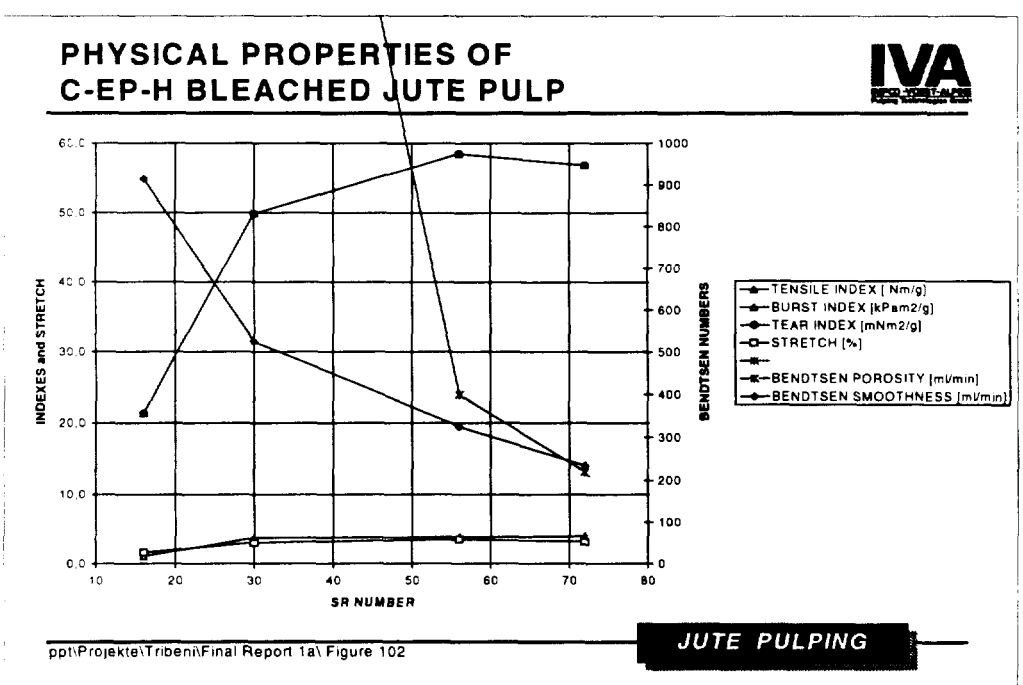

TENSILE INDEX [Nm/g] OF
UNBLEACHED KRAFT-AQ JUTE PULP AT 50 SR
IVA
100.00
90.00
80.00
70.00
60.00
50.00
40.00
30.00
20.00
10.00
0.00
IVA LAB
CPPRI LAB
TTD LAB
CPPRI PILOT PLANT
ppt\Projekte\Triben\Final Report 1a\ Figure 90
JUTE PULPING

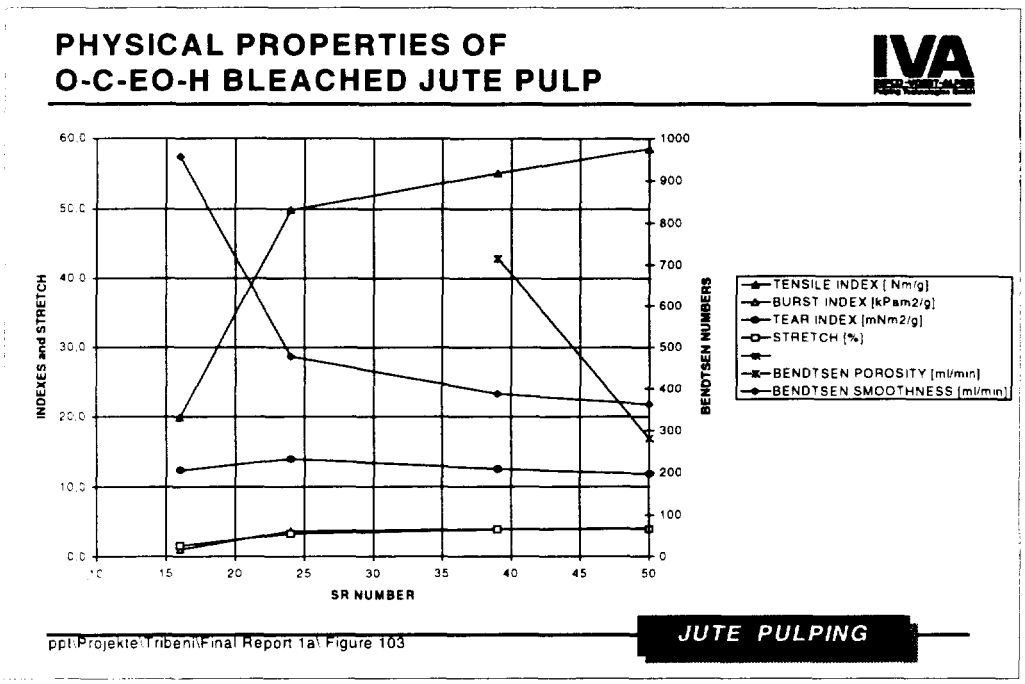

BURST INDEX [kPam2/g]OF
UNBLEACHED KRAFT-AQ JUTE PULP AT 50 SR
IVA
7.00
6.00
5.00
4.00
3.00
2.00
1.00
0.00
IVA LAB
CPPRI LAB
TTD LAB
CPPRI PILOT PLANT
ppt\Projekte\Triben\Final Report 1a\ Figure 91
JUTE PULPING

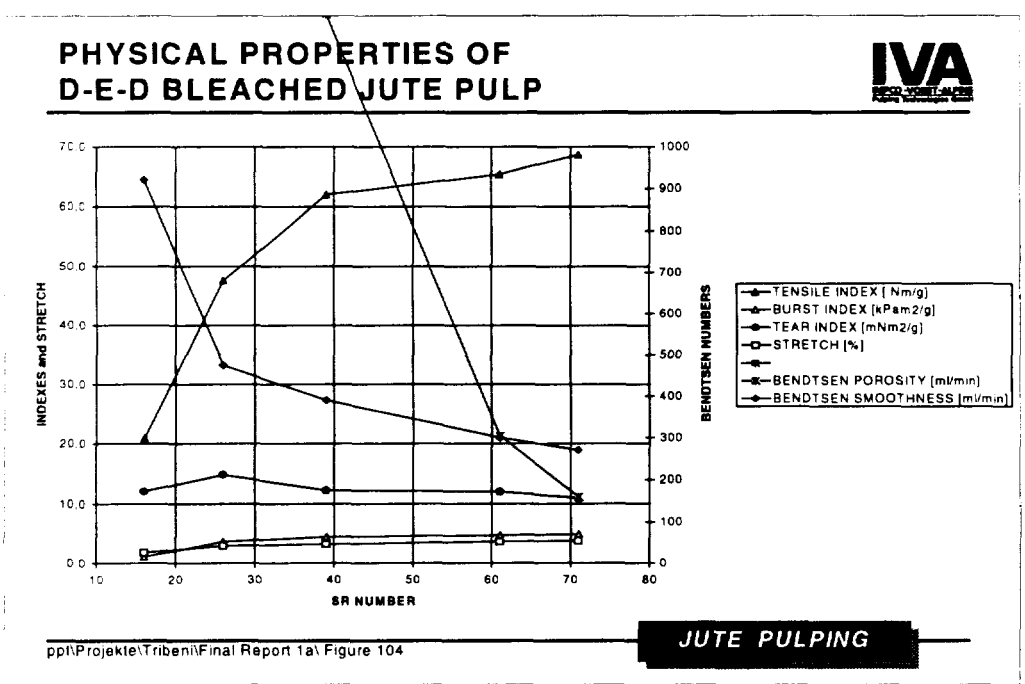

TEAR INDEX [mNm2/g]OF
UNBLEACHED KRAFT-AQ JUTE PULP AT 50 SR
IVA
14.00
12.00
10.00
8.00
6.00
4.00
2.00
0.00
IVA LAB
CPPRI LAB
TTD LAB
CPPRI PILOT PLANT
ppt\Projekte\Triben\Final Report 1a\ Figure 92
JUTE PULPING

11.4 Bench scale bleaching tests

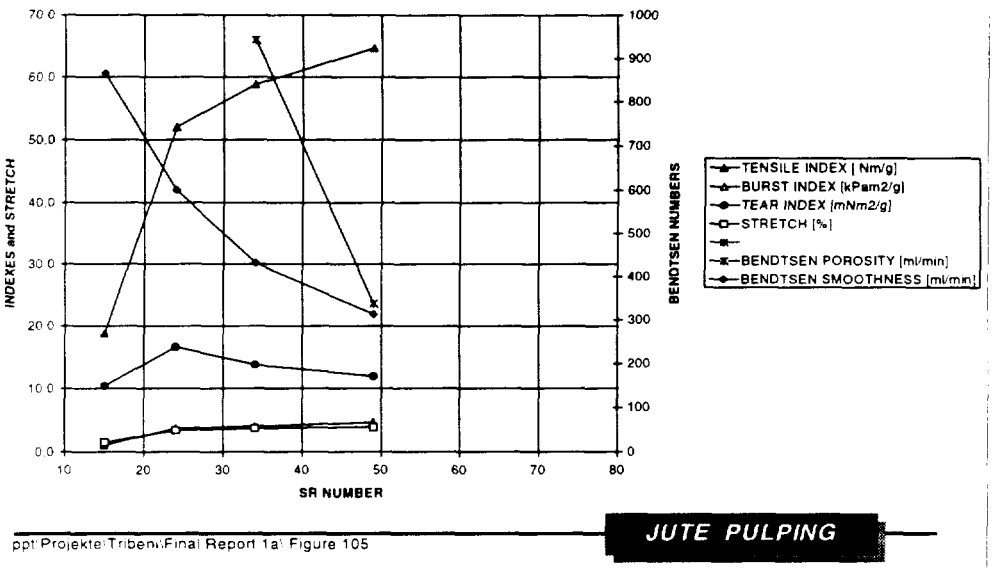

PHYSICAL PROPERTIES OF
C-E-H BLEACHED JUTE PULP
IVA
INDEXES and STRETCH
BENDTSEN NUMBERS
SR NUMBER
TENSILE INDEX [Nm/g]
BURST INDEX [kPam2/g]
TEAR INDEX [mNm2/g]
STRETCH [%]
BENDTSEN POROSITY [ml/min]
BENDTSEN SMOOTHNESS [ml/min]
ppt\Projekte\Tribeni\Final Report 1a\ Figure 101
JUTE PULPING


PHYSICAL PROPERTIES OF
C-EP-H BLEACHED JUTE PULP
IVA
INDEXES and STRETCH
BENDTSEN NUMBERS
SR NUMBER
TENSILE INDEX [Nm/g]
BURST INDEX [kPam2/g]
TEAR INDEX [mNm2/g]
STRETCH [%]
BENDTSEN POROSITY [ml/min]
BENDTSEN SMOOTHNESS [ml/min]
ppt\Projekte\Tribeni\Final Report 1a\ Figure 102
JUTE PULPING


PHYSICAL PROPERTIES OF
O-C-EO-H BLEACHED JUTE PULP
IVA
INDEXES and STRETCH
BENDTSEN NUMBERS
SR NUMBER
TENSILE INDEX [Nm/g]
BURST INDEX [kPam2/g]
TEAR INDEX [mNm2/g]
STRETCH [%]
BENDTSEN POROSITY [ml/min]
BENDTSEN SMOOTHNESS [ml/min]
ppt\Projekte\Tribeni\Final Report 1a\ Figure 103
JUTE PULPING


PHYSICAL PROPERTIES OF
D-E-D BLEACHED JUTE PULP
IVA
INDEXES and STRETCH
BENDTSEN NUMBERS
SR NUMBER
TENSILE INDEX [Nm/g]
BURST INDEX [kPam2/g]
TEAR INDEX [mNm2/g]
STRETCH [%]
BENDTSEN POROSITY [ml/min]
BENDTSEN SMOOTHNESS [ml/min]
ppt\Projekte\Tribeni\Final Report 1a\ Figure 104
JUTE PULPING

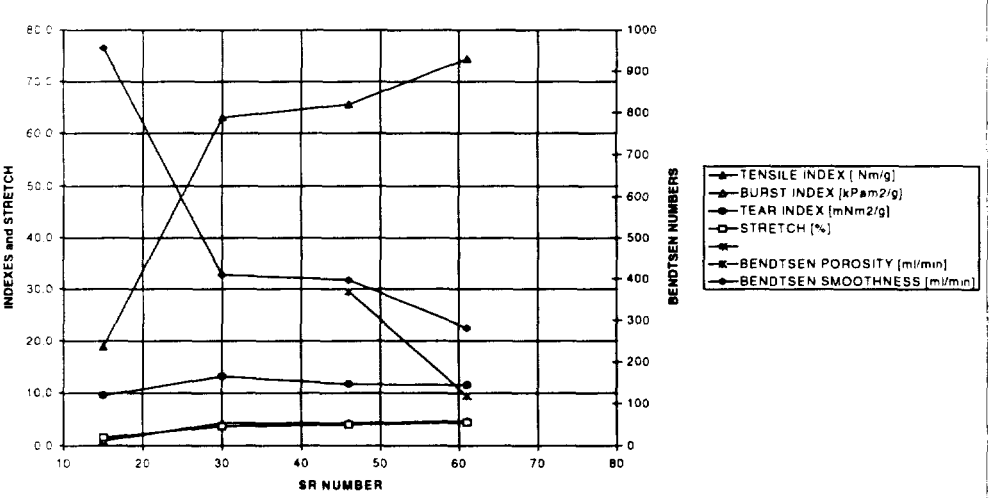
PHYSICAL PROPERTIES OF O-D-EO-D BLEACHED JUTE PULP



ppt\Projekte\Triben\Final Report 1a\ Figure 105

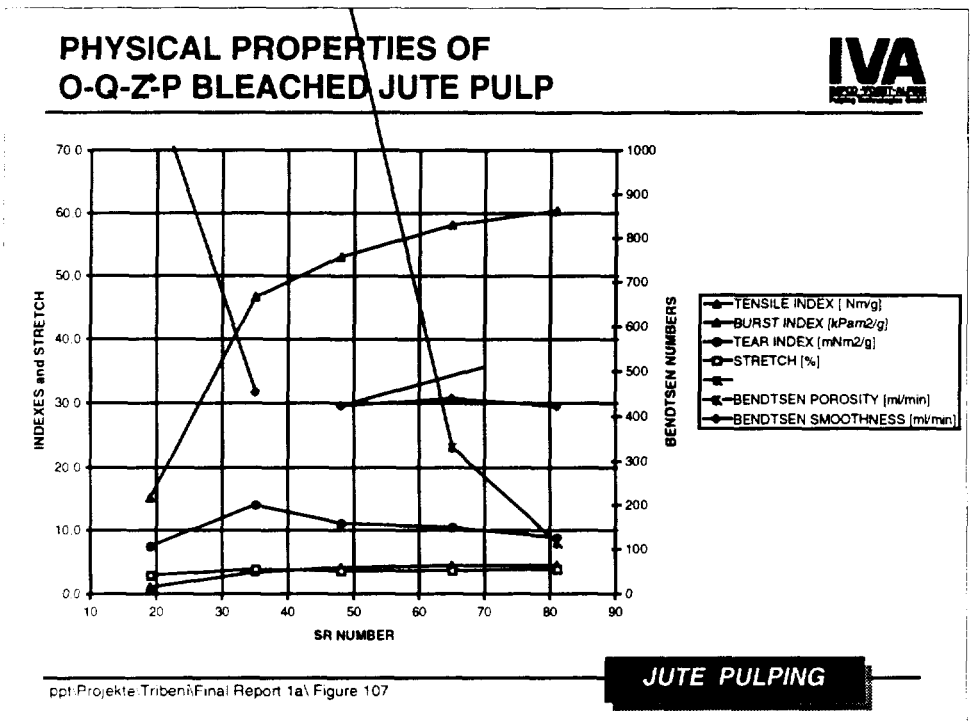
JUTE PULPING

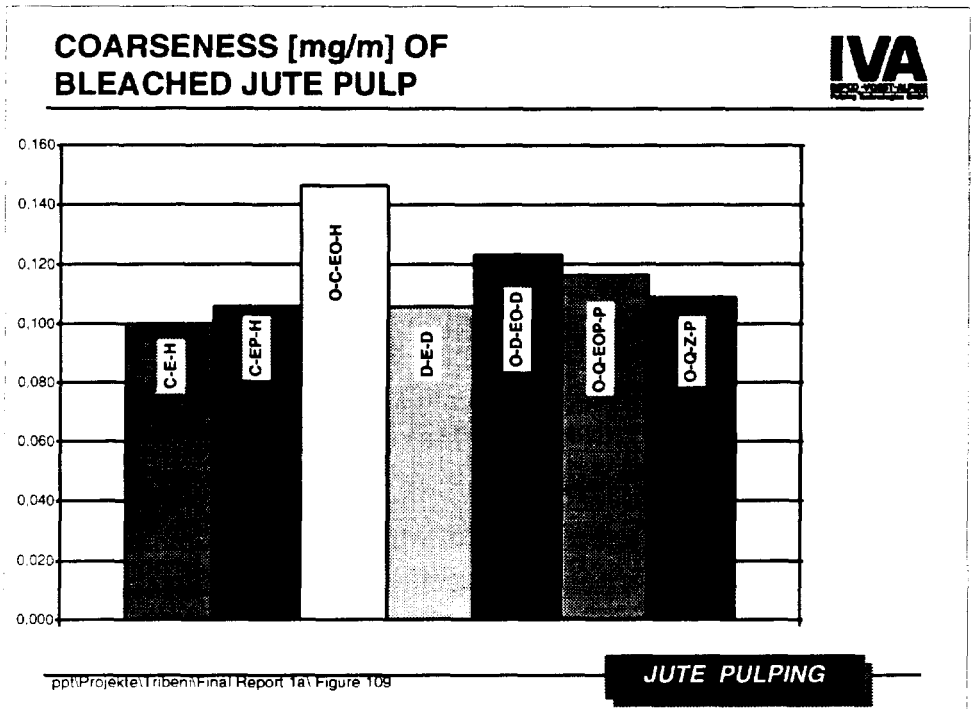
PHYSICAL PROPERTIES OF O-Q-EOP-P BLEACHED JUTE PULP

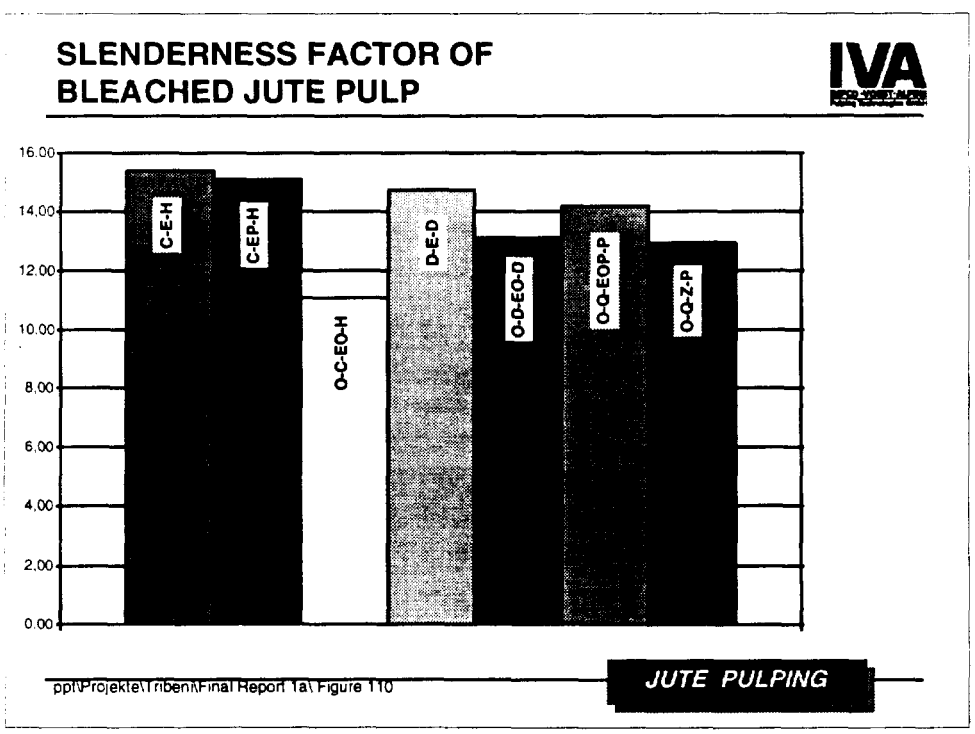


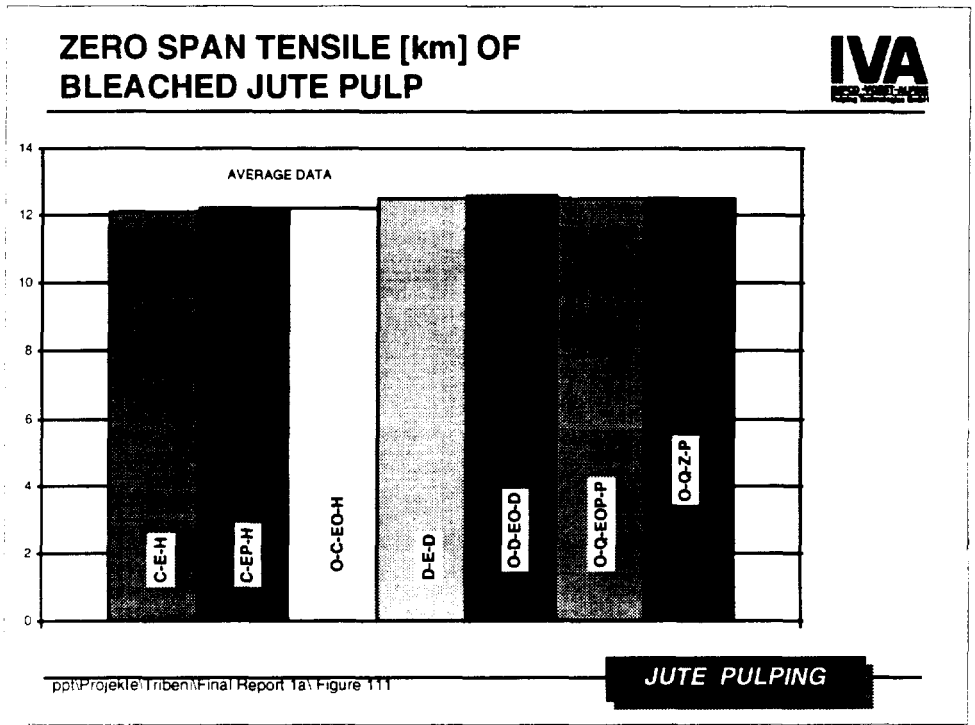
ppt\Projekte\Triben\Final Report 1a\ Figure 106

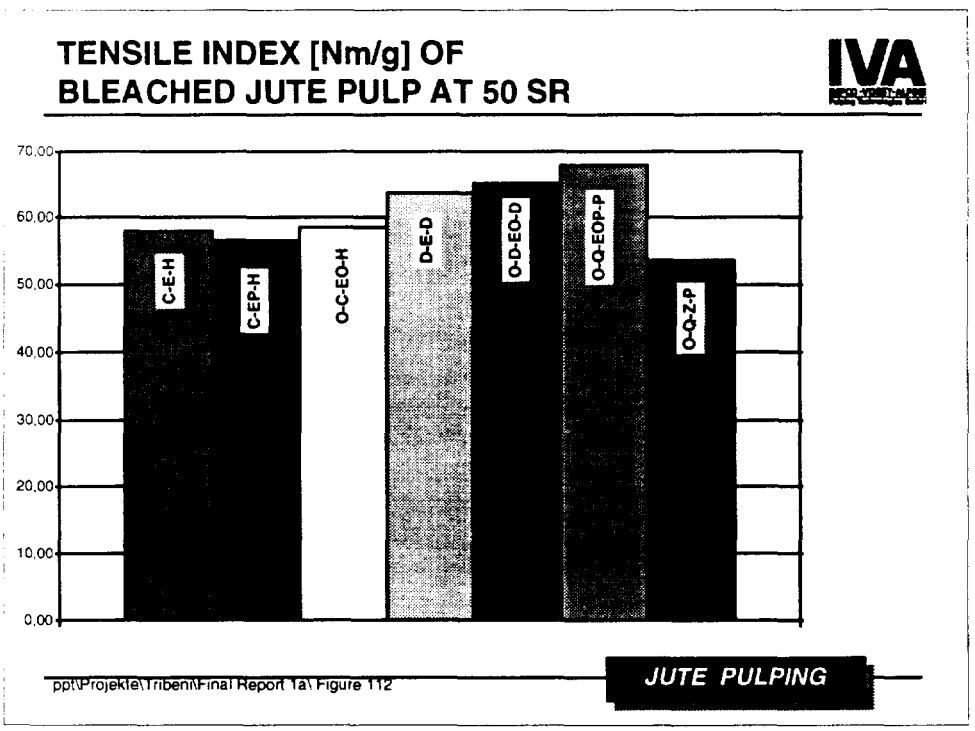
JUTE PULPING

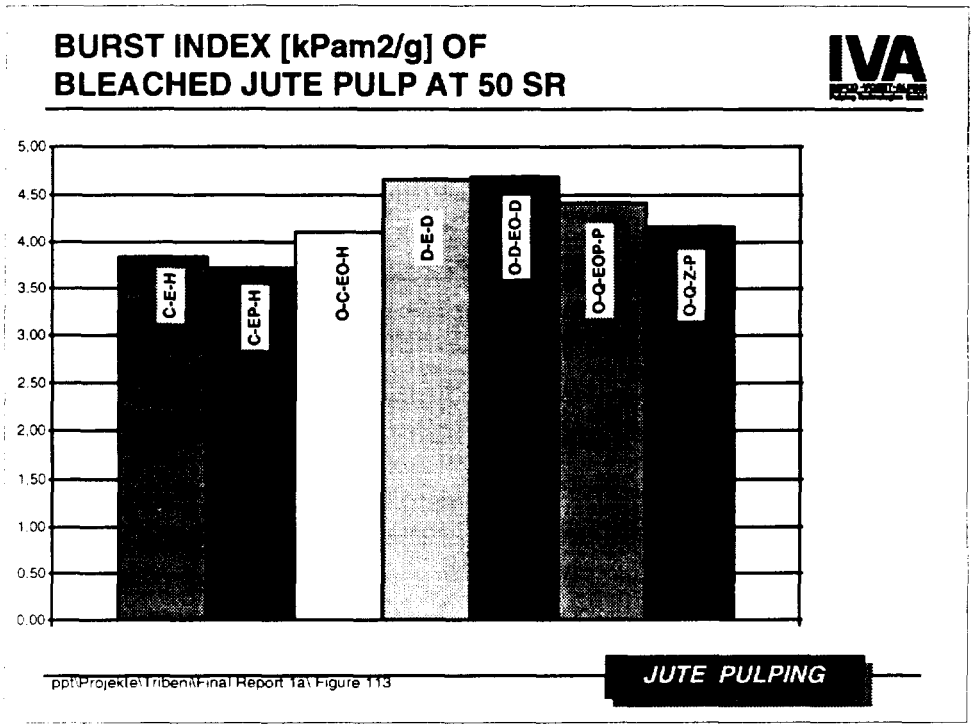

PHYSICAL PROPERTIES OF
O-Q-Z*-P BLEACHED JUTE PULP
IVA
INDEXES and STRETCH
BENDTSEN NUMBERS
SR NUMBER
TENSILE INDEX [Nm/g]
BURST INDEX [kPam2/g]
TEAR INDEX [mNm2/g]
STRETCH [%]
BENDTSEN POROSITY [ml/min]
BENDTSEN SMOOTHNESS [ml/min]
ppt:Projekte:Tribeni\Final Report 1a\ Figure 107
JUTE PULPING

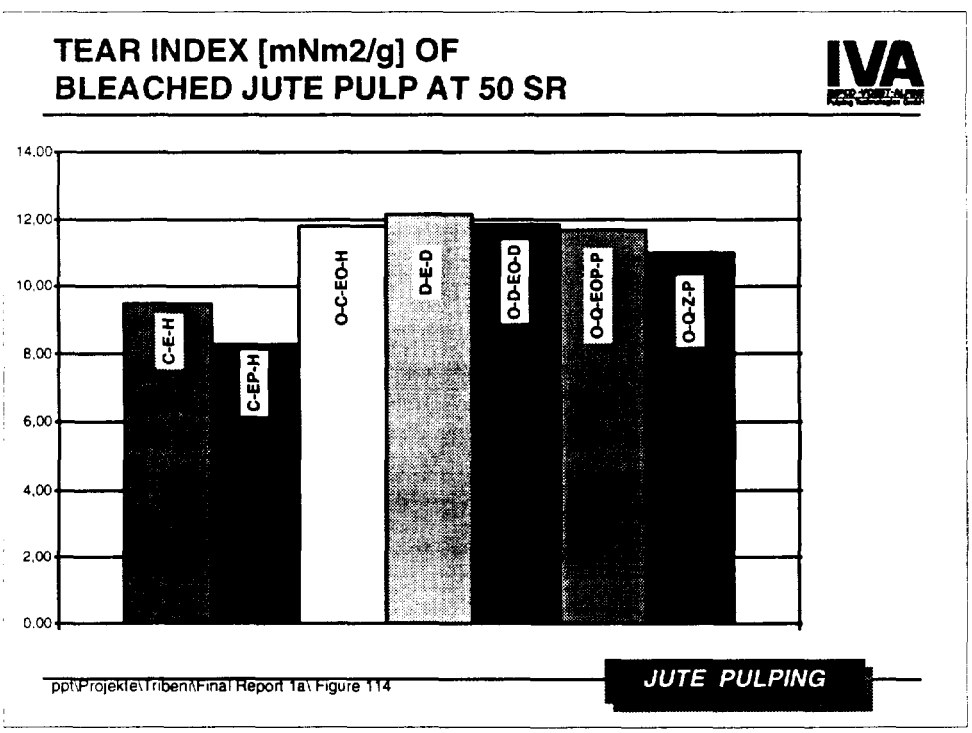

COARSENESS [mg/m] OF
BLEACHED JUTE PULP
IVA
0.160
0.140
0.120
0.100
0.080
0.060
0.040
0.020
0.000
C-E-H
C-EP-H
O-C-EO-H
D-E-D
O-D-EO-D
O-Q-EOP-P
O-Q-Z-P
ppt\Projekte\Tribeni\Final Report 1a\ Figure 109
JUTE PULPING

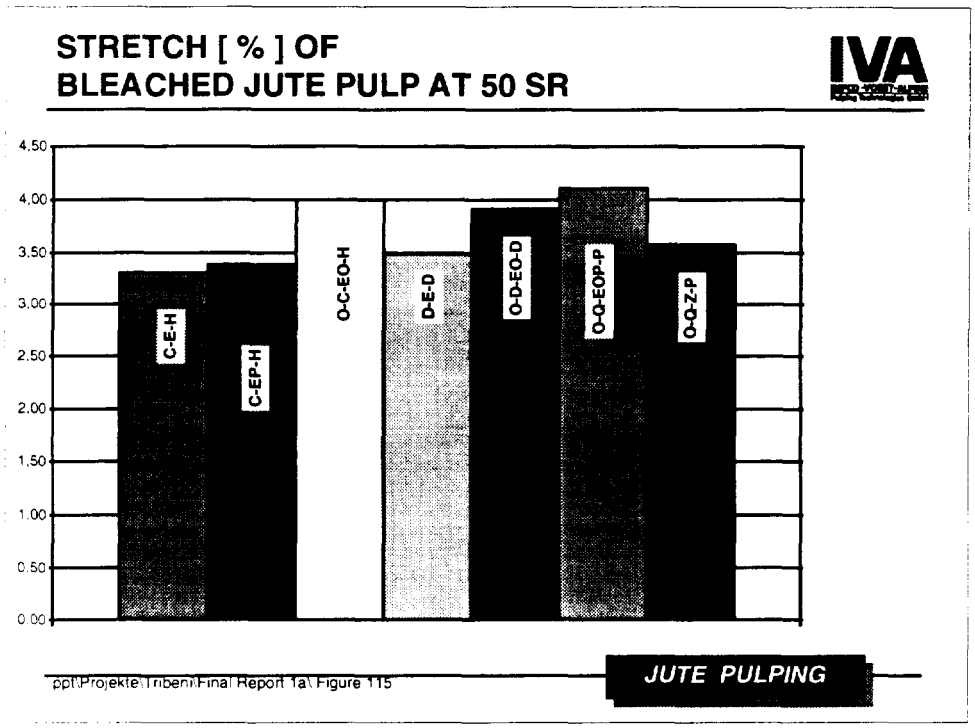

SLENDERNESS FACTOR OF
BLEACHED JUTE PULP
IVA
16.00
14.00
12.00
10.00
8.00
6.00
4.00
2.00
0.00
C-E-H
C-EP-H
O-C-EO-H
D-E-D
O-D-EO-D
O-Q-EOP-P
O-Q-Z-P
ppt\Projekte\Tribeni\Final Report 1a\ Figure 110
JUTE PULPING

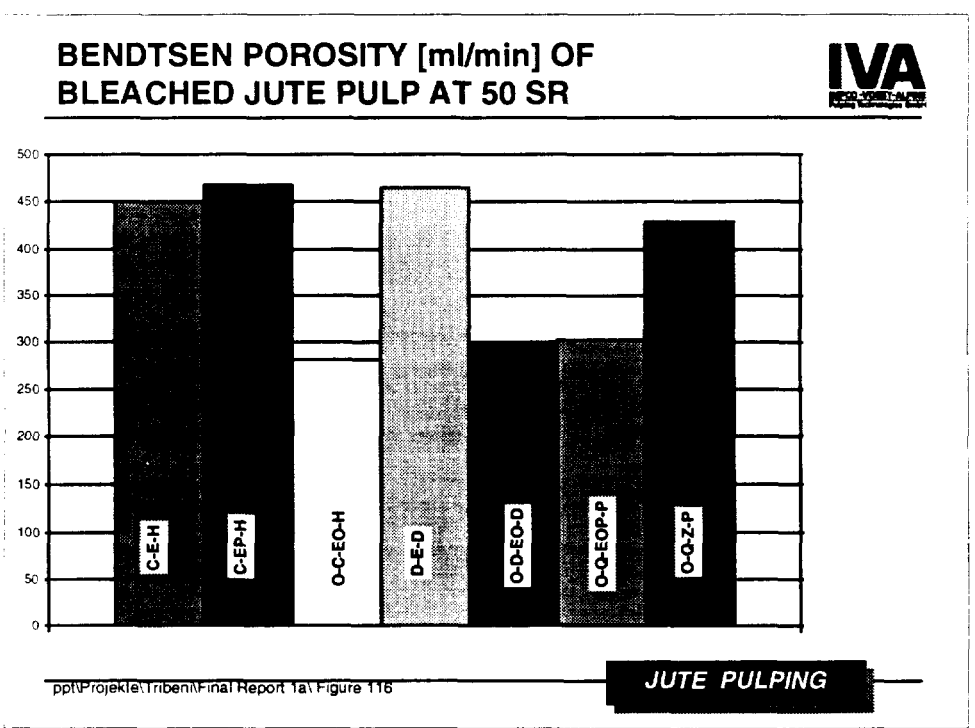

ZERO SPAN TENSILE [km] OF
BLEACHED JUTE PULP
IVA
AVERAGE DATA
14
12
10
8
6
4
2
0
C-E-H
C-EP-H
O-C-EO-H
D-E-D
O-D-EO-D
O-Q-EOP-P
O-Q-Z-P
ppt\Projekte\Triben\Final Report 1a\ Figure 111
JUTE PULPING

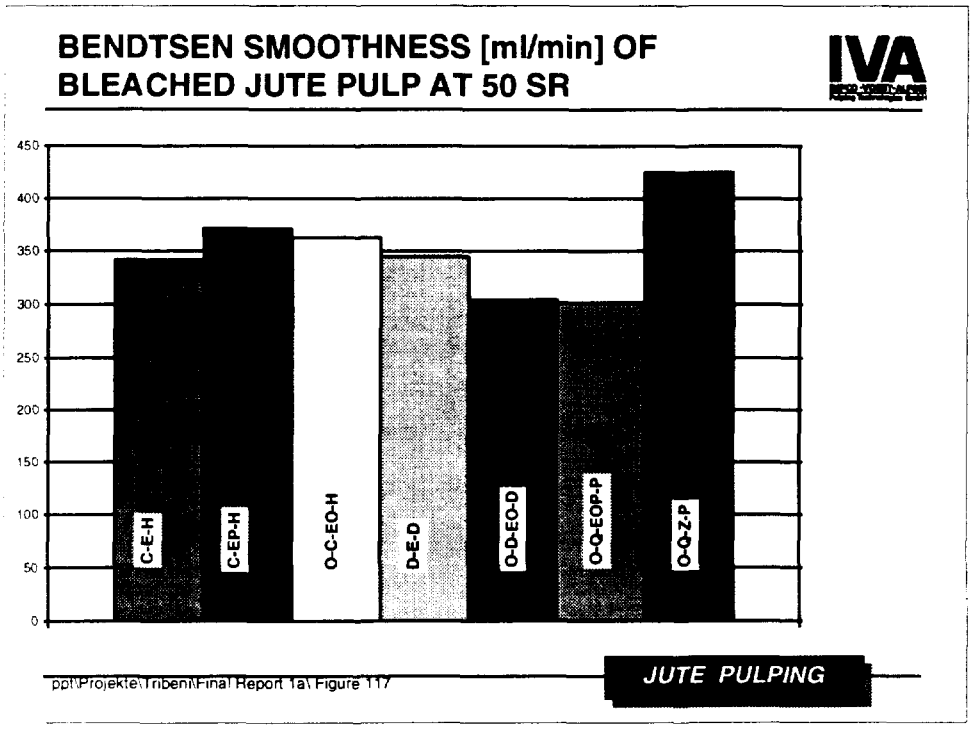

TENSILE INDEX [Nm/g] OF
BLEACHED JUTE PULP AT 50 SR
IVA
70,00
60,00
50,00
40,00
30,00
20,00
10,00
0,00
C-E-H
C-EP-H
O-C-EO-H
D-E-D
O-D-EO-D
O-Q-EOP-P
O-Q-Z-P
ppt\Projekte\Triben\Final Report 1a\ Figure 112
JUTE PULPING

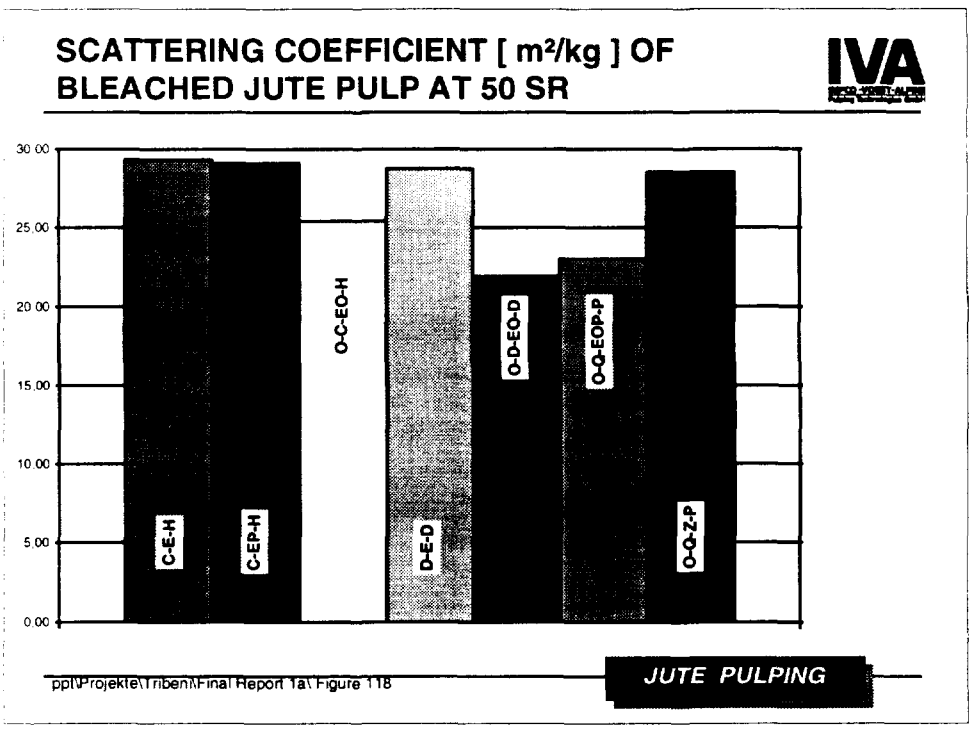

BURST INDEX [kPam2/g] OF
BLEACHED JUTE PULP AT 50 SR
IVA
5.00
4.50
4.00
3.50
3.00
2.50
2.00
1.50
1.00
0.50
0.00
C-E-H
C-EP-H
O-C-EO-H
D-E-D
O-D-EO-D
O-Q-EOP-P
O-Q-Z-P
ppt\Projekte\Triben\Final Report 1a\ Figure 113
JUTE PULPING

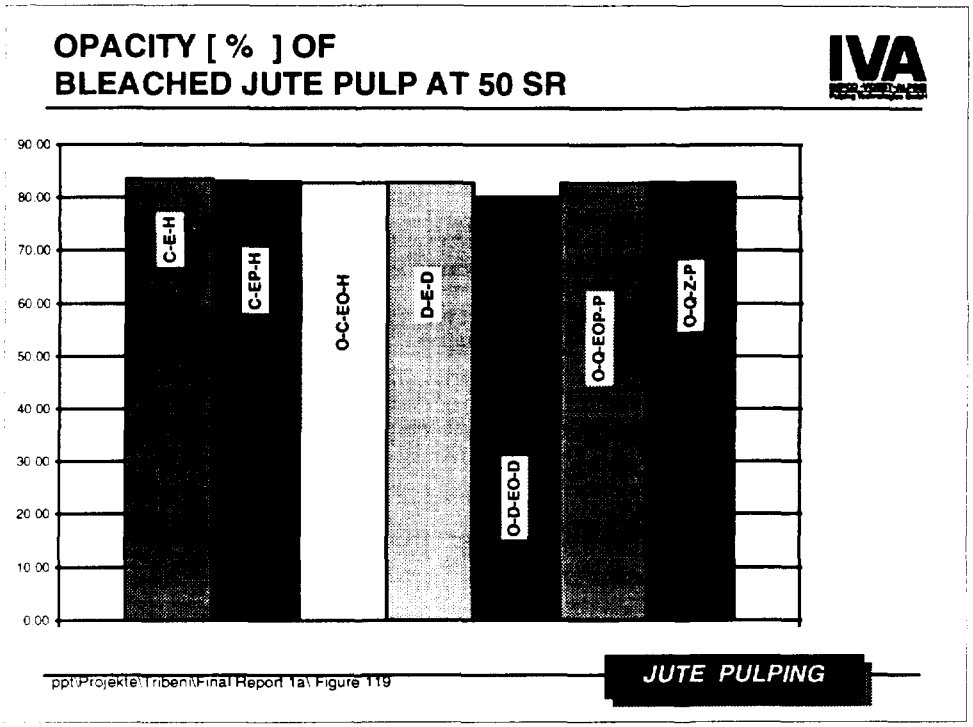

TEAR INDEX [mNm2/g] OF
BLEACHED JUTE PULP AT 50 SR
IVA
14.00
12.00
10.00
8.00
6.00
4.00
2.00
0.00
C-E-H
C-EP-H
O-C-EO-H
D-E-D
O-D-EO-D
O-Q-EOP-P
O-Q-Z-P
ppt\Projekte\Triben\Final Report 1a\ Figure 114
JUTE PULPING

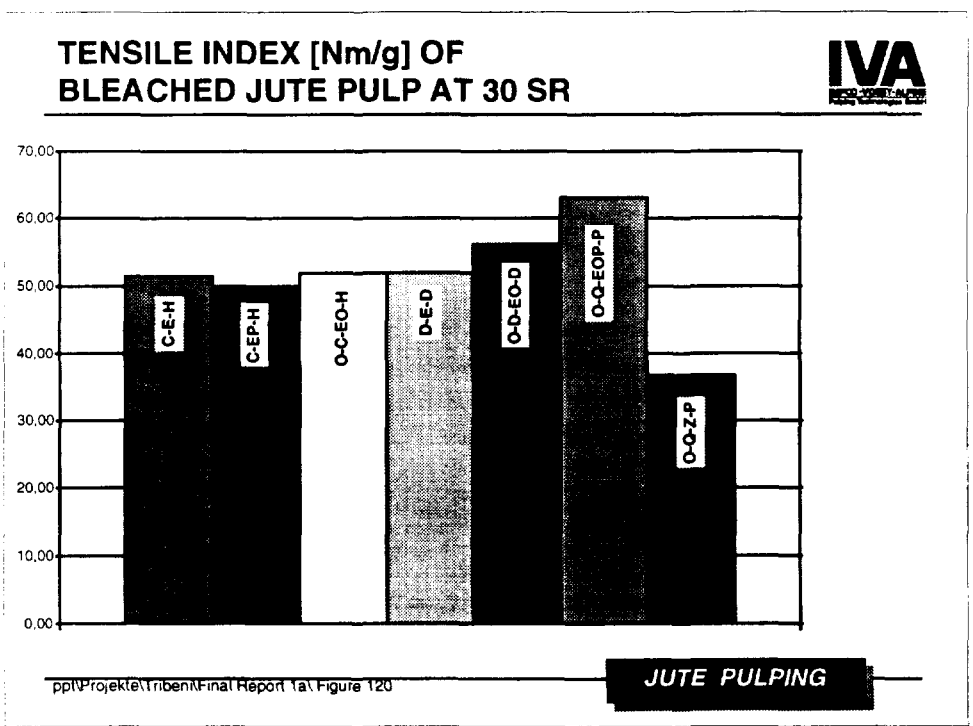

STRETCH [%] OF
BLEACHED JUTE PULP AT 50 SR
IVA
4.50
4.00
3.50
3.00
2.50
2.00
1.50
1.00
0.50
0.00
C-E-H
C-EP-H
O-C-EO-H
D-E-D
O-D-EO-D
O-Q-EOP-P
O-Q-Z-P
ppt\Projekte\Triben\Final Report 1a\ Figure 115
JUTE PULPING

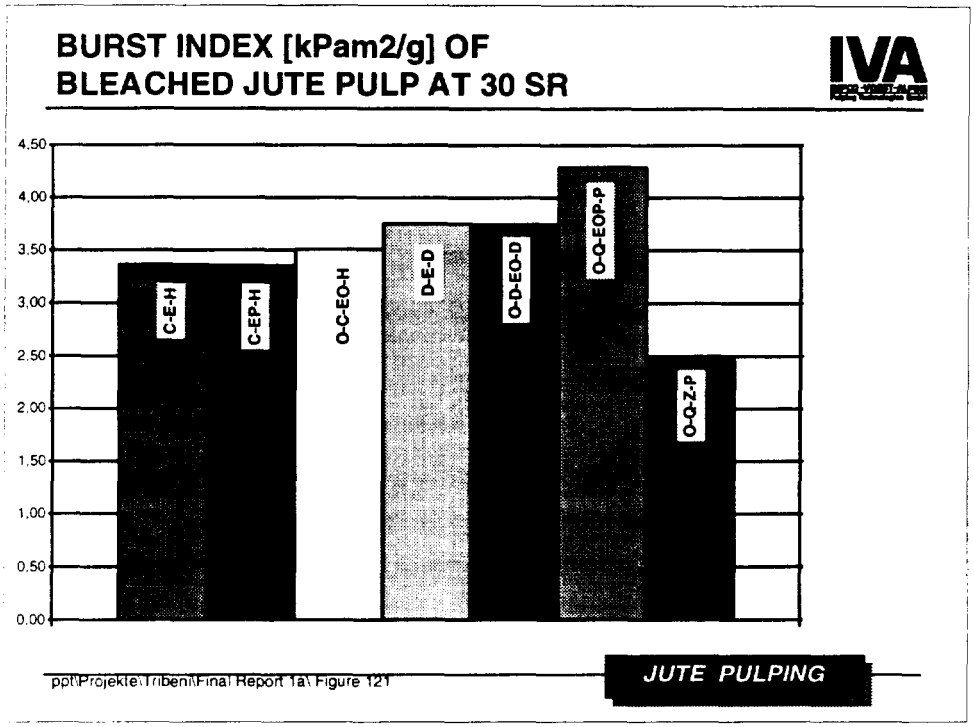

BENDTSEN POROSITY [ml/min] OF
BLEACHED JUTE PULP AT 50 SR
IVA
500
450
400
350
300
250
200
150
100
50
0
C-E-H
C-EP-H
O-C-EO-H
D-E-D
O-D-EO-D
O-Q-EOP-P
O-Q-Z-P
ppt\Projekte\Triben\Final Report 1a\ Figure 116
JUTE PULPING

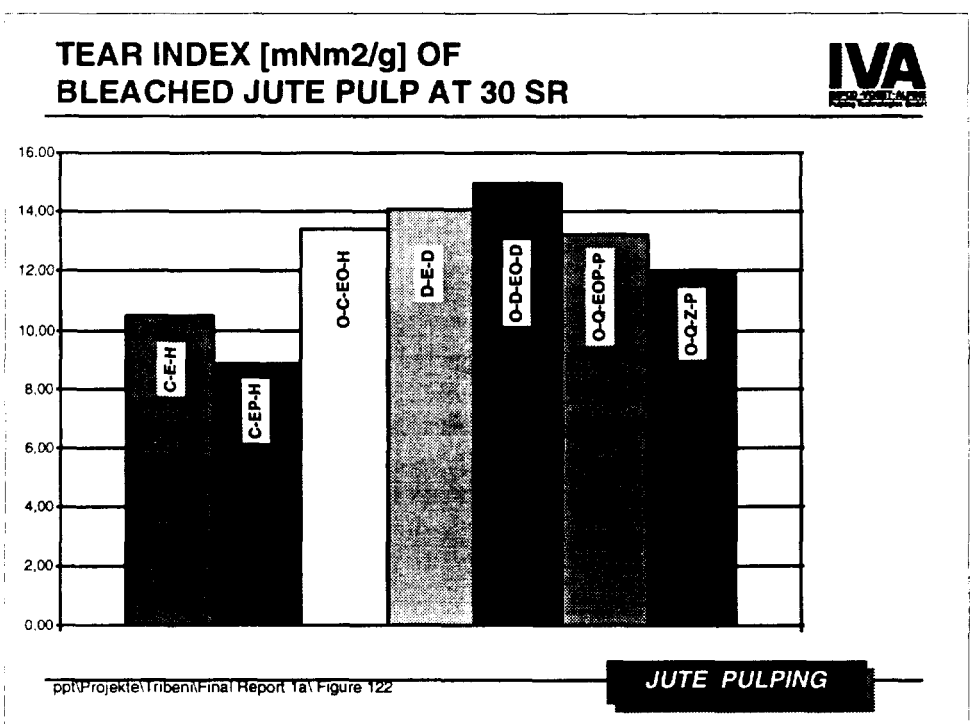

BENDTSEN SMOOTHNESS [ml/min] OF BLEACHED JUTE PULP AT 50 SR
IVA
450
400
350
300
250
200
150
100
50
0
C-E-H
C-EP-H
O-C-EO-H
D-E-D
O-D-EO-D
O-Q-EOP-P
O-Q-Z-P
ppt\Projekte\Triben\Final Report 1a\ Figure 117
JUTE PULPING

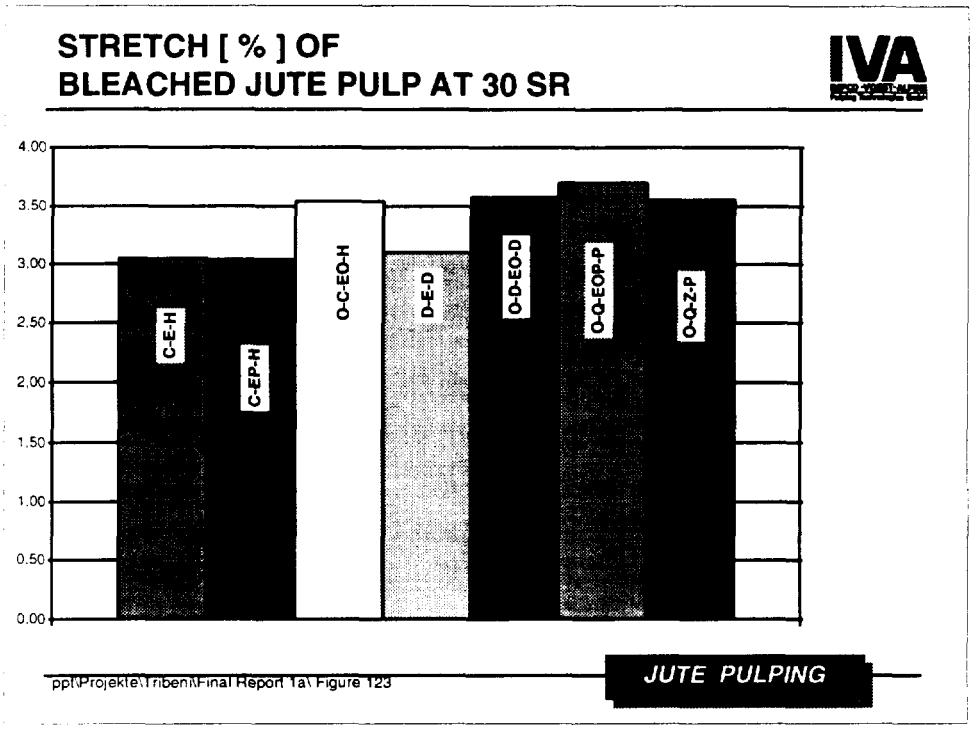

SCATTERING COEFFICIENT [m²/kg] OF BLEACHED JUTE PULP AT 50 SR
IVA
30.00
25.00
20.00
15.00
10.00
5.00
0.00
C-E-H
C-EP-H
O-C-EO-H
D-E-D
O-D-EO-D
O-Q-EOP-P
O-Q-Z-P
ppt\Projekte\Triben\Final Report 1a\ Figure 118
JUTE PULPING

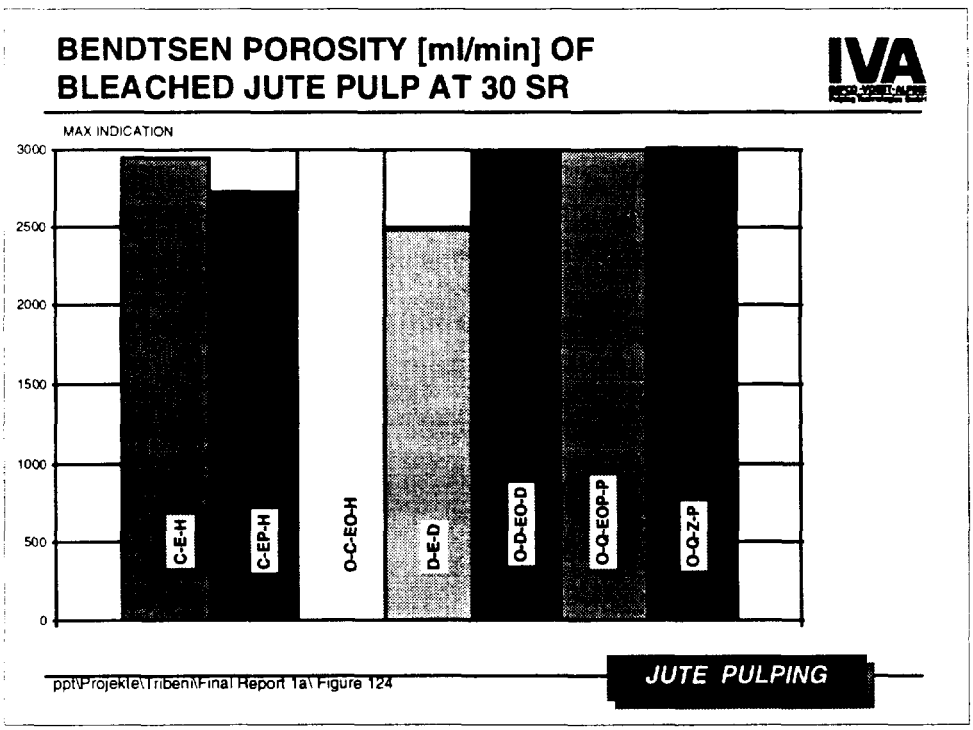

OPACITY [%] OF
BLEACHED JUTE PULP AT 50 SR
IVA
90.00
80.00
70.00
60.00
50.00
40.00
30.00
20.00
10.00
0.00
C-E-H
C-EP-H
O-C-EO-H
D-E-D
O-D-EO-D
O-Q-EOP-P
O-Q-Z-P
ppt\Projekte\Tribeni\Final Report 1a\ Figure 119
JUTE PULPING

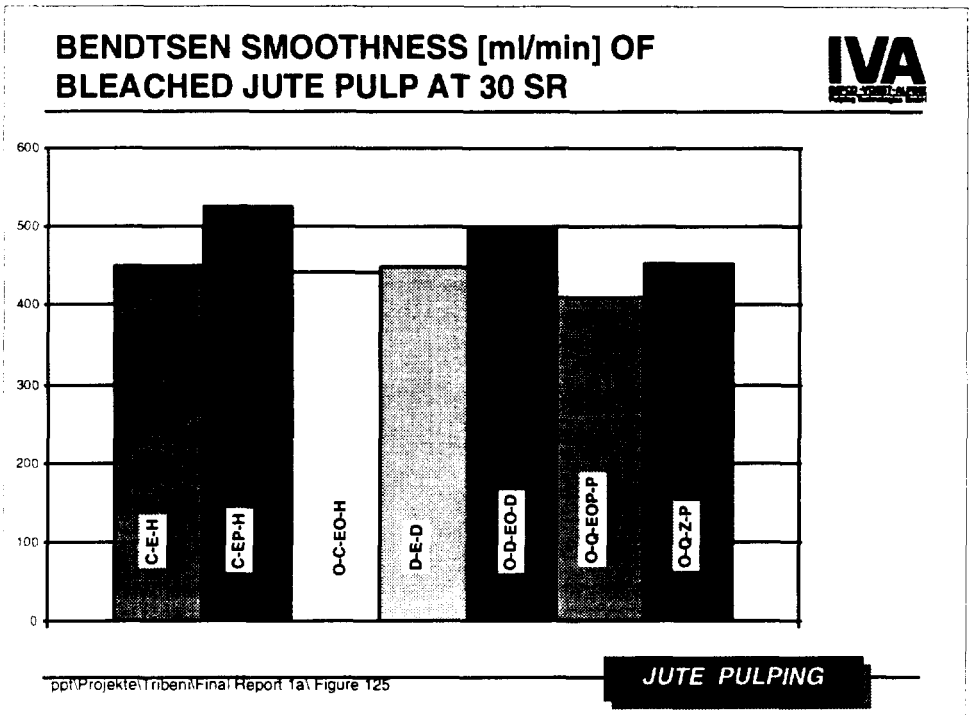

TENSILE INDEX [Nm/g] OF
BLEACHED JUTE PULP AT 30 SR
IVA
70,00
60,00
50,00
40,00
30,00
20,00
10,00
0,00
C-E-H
C-EP-H
O-C-EO-H
D-E-D
O-D-EO-D
O-Q-EOP-P
O-Q-Z-P
ppt\Projekte\Tribeni\Final Report 1a\ Figure 120
JUTE PULPING

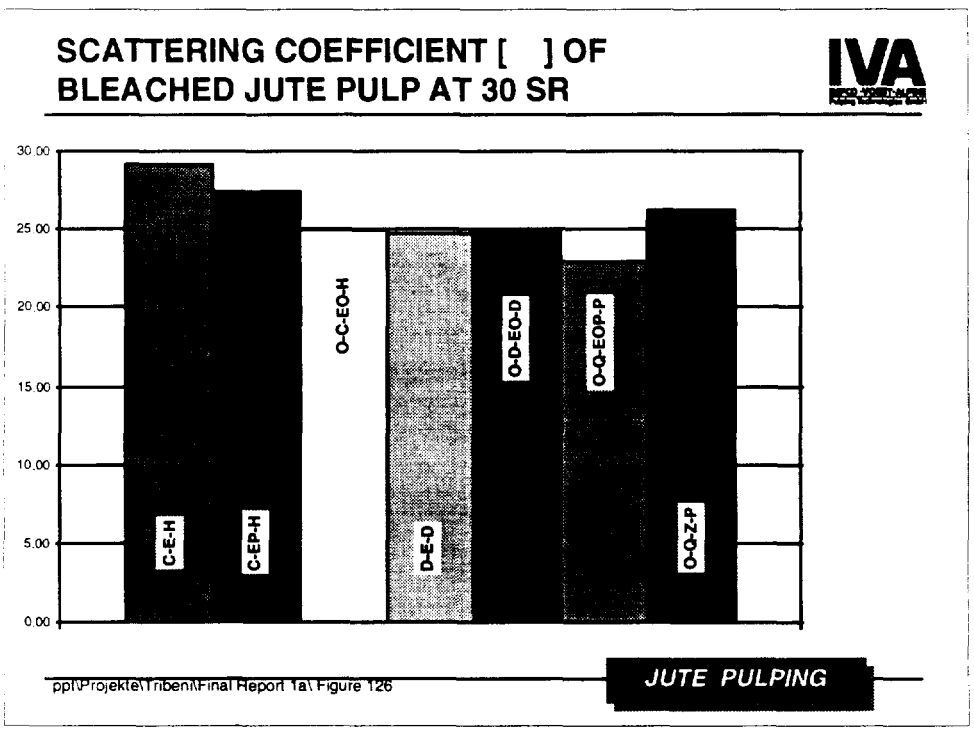

BURST INDEX [kPam2/g] OF
BLEACHED JUTE PULP AT 30 SR
IVA
4.50
4.00
3.50
3.00
2.50
2.00
1.50
1.00
0.50
0.00
C-E-H
C-EP-H
O-C-EO-H
D-E-D
O-D-EO-D
O-Q-EOP-P
O-Q-Z-P
ppt\Projekte\Tribeni\Final Report 1a\ Figure 121
JUTE PULPING

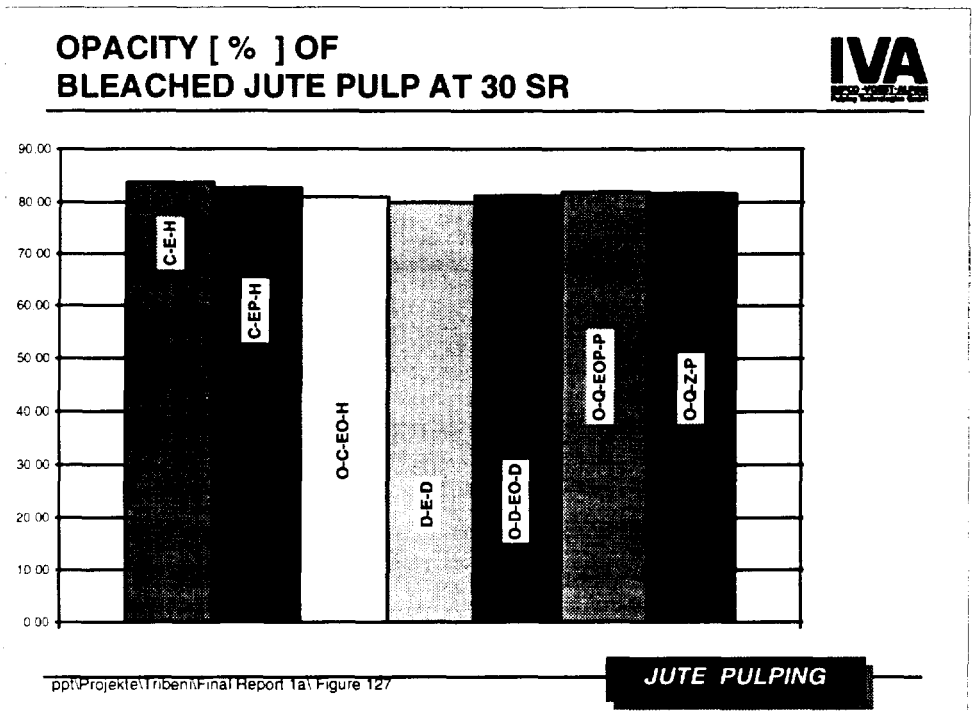

TEAR INDEX [mNm2/g] OF
BLEACHED JUTE PULP AT 30 SR
IVA
16.00
14.00
12.00
10.00
8.00
6.00
4.00
2.00
0.00
C-E-H
C-EP-H
O-C-EO-H
D-E-D
O-D-EO-D
O-Q-EOP-P
O-Q-Z-P
ppt\Projekte\Tribeni\Final Report 1a\ Figure 122
JUTE PULPING

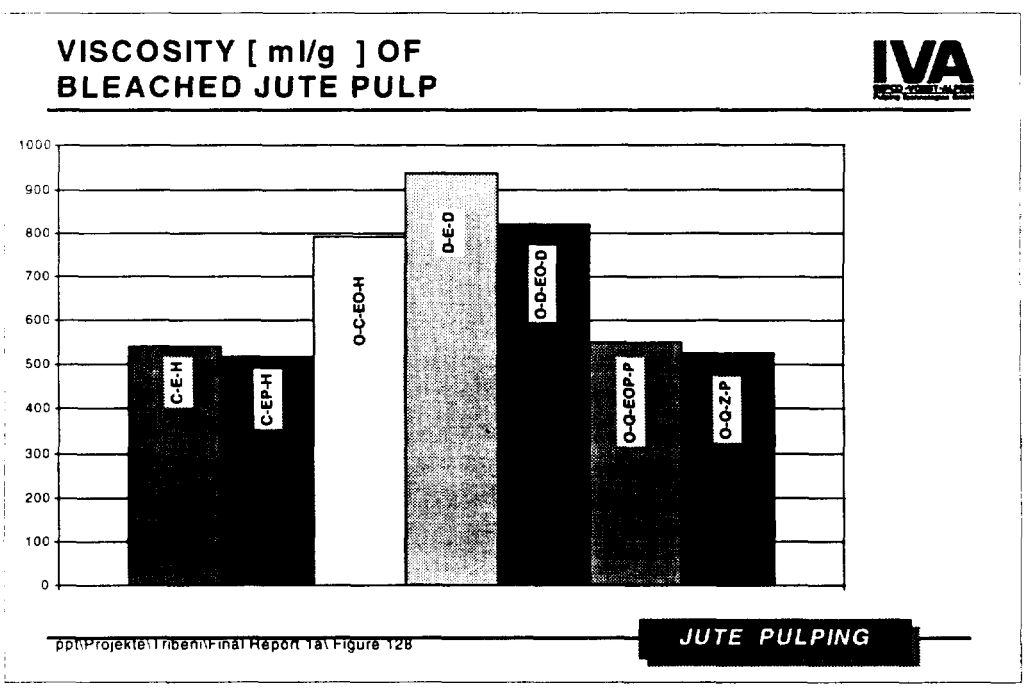

STRETCH [%] OF
BLEACHED JUTE PULP AT 30 SR
IVA
4.00
3.50
3.00
2.50
2.00
1.50
1.00
0.50
0.00
C-E-H
C-EP-H
O-C-EO-H
D-E-D
O-D-EO-D
O-Q-EOP-P
O-Q-Z-P
ppt\Projekte\Triben\Final Report 1a\ Figure 123
JUTE PULPING


BENDTSEN POROSITY [ml/min] OF
BLEACHED JUTE PULP AT 30 SR
IVA
MAX INDICATION
3000
2500
2000
1500
1000
500
0
C-E-H
C-EP-H
O-C-EO-H
D-E-D
O-D-EO-D
O-Q-EOP-P
O-Q-Z-P
ppt\Projekte\Triben\Final Report 1a\ Figure 124
JUTE PULPING

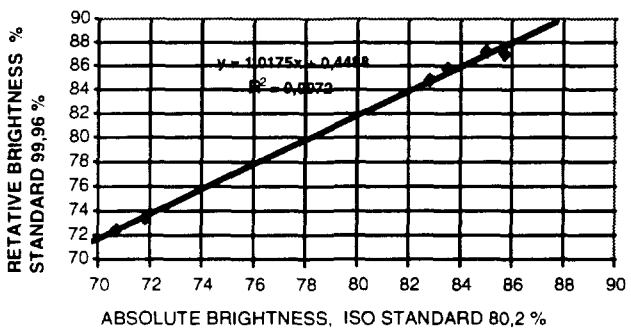

BENDTSEN SMOOTHNESS [ml/min] OF
BLEACHED JUTE PULP AT 30 SR
IVA
600
500
400
300
200
100
0
C-E-H
C-EP-H
O-C-EO-H
D-E-D
O-D-EO-D
O-Q-EOP-P
O-Q-Z-P
ppt\Projekte\Triben\Final Report 1a\ Figure 125
JUTE PULPING


SCATTERING COEFFICIENT [ ] OF
BLEACHED JUTE PULP AT 30 SR
IVA
30.00
25.00
20.00
15.00
10.00
5.00
0.00
C-E-H
C-EP-H
O-C-EO-H
D-E-D
O-D-EO-D
O-Q-EOP-P
O-Q-Z-P
ppt\Projekte\Triben\Final Report 1a\ Figure 126
JUTE PULPING


OPACITY [%] OF
BLEACHED JUTE PULP AT 30 SR
IVA
90.00
80.00
70.00
60.00
50.00
40.00
30.00
20.00
10.00
0.00
C-E-H
C-EP-H
O-C-EO-H
D-E-D
O-D-EO-D
O-Q-EOP-P
O-Q-Z-P
ppt\Projekte\Tribeni\Final Report 1a\ Figure 127
JUTE PULPING


VISCOSITY [ml/g] OF
BLEACHED JUTE PULP
IVA
1000
900
800
700
600
500
400
300
200
100
0
C-E-H
C-EP-H
O-C-EO-H
D-E-D
O-D-EO-D
O-Q-EOP-P
O-Q-Z-P
ppt\Projekte\Tribeni\Final Report 1a\ Figure 128
JUTE PULPING

CORELATION BETWEEN ABSOLUTE ISO- AND RELATIVE BRIGHTNESS



Messured at ÖHFI, Vienna sept. 1995

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JUTE PULPING

FIBRE DISTRIBUTION AND ANALYSIS OF UNBLEACHED JUTE PULP

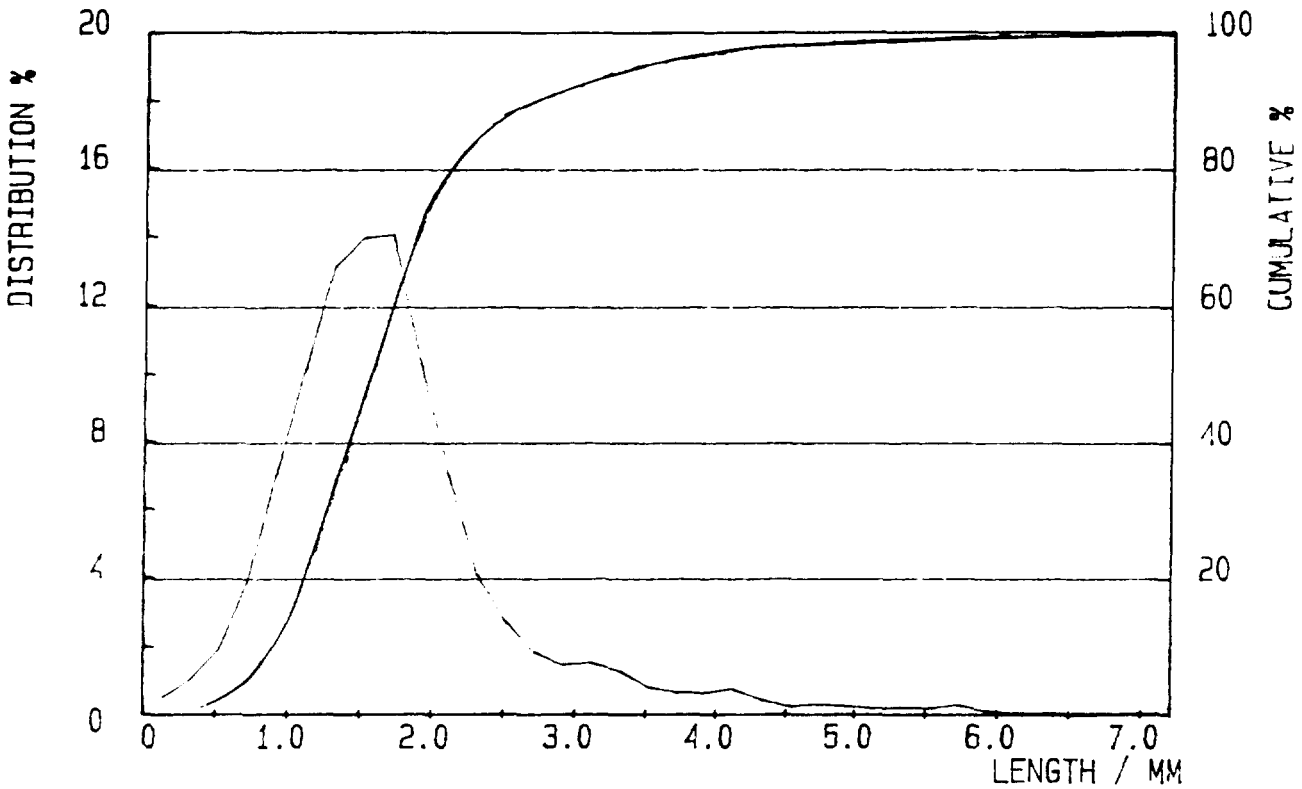
WITH

KAJAANI FS-200

KAJAANI FS-200 KRAFT 02-03-95 12:01

WEIGHTED DISTRIBUTION

SAMPLE TITLE	N/14/95 P 3B JUTA	SAMPLE FILE NO	006
SAMPLED	01-03-95	UPPER LIMIT	6.00
ANALYSED	02-03-95 11:57	LOWER LIMIT	0.00
TOTAL FIBERS	24908	WEIGHT	9.07 mg



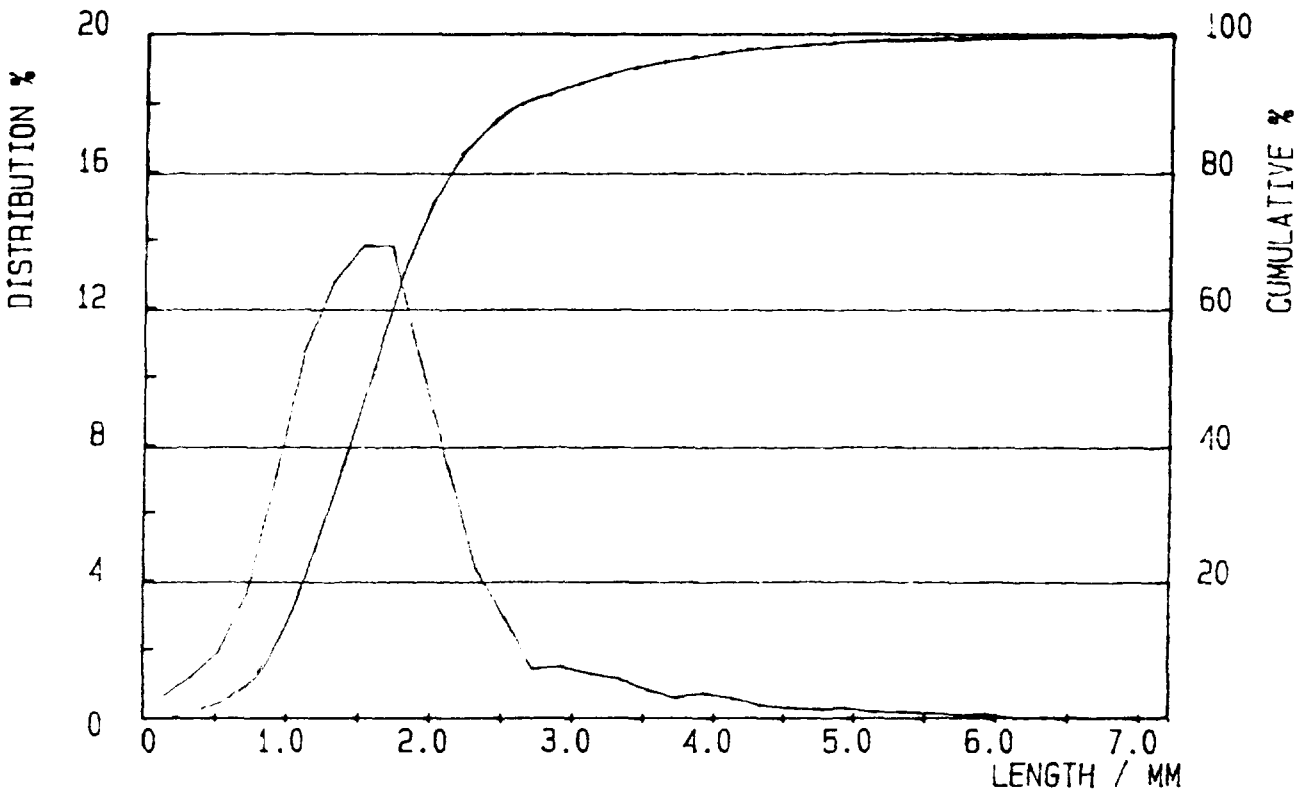
ARITHMETIC AV	1.27 mm	COARSENESS	0.104 mg/m
L WEIGHTED AV	1.69 mm	WOOD SPEC	0.0 %
W WEIGHTED AV	2.09 mm	CUSTOM /L VALUE OUT OF TABLE	

LENGTH 0.20 mm P= 7.02 % W= 0.45 %

KAJAANI FS-200 **KRAFT-AQ** 02-03-95 12: 14

WEIGHTED DISTRIBUTION

SAMPLE TITLE	N/14/95 P 4B JUTA	SAMPLE FILE NO	007
SAMPLED	01-03-95	UPPER LIMIT	6.00
ANALYSED	02-03-95 12: 12	LOWER LIMIT	0.00
TOTAL FIBERS	27041	WEIGHT	8.80 mg



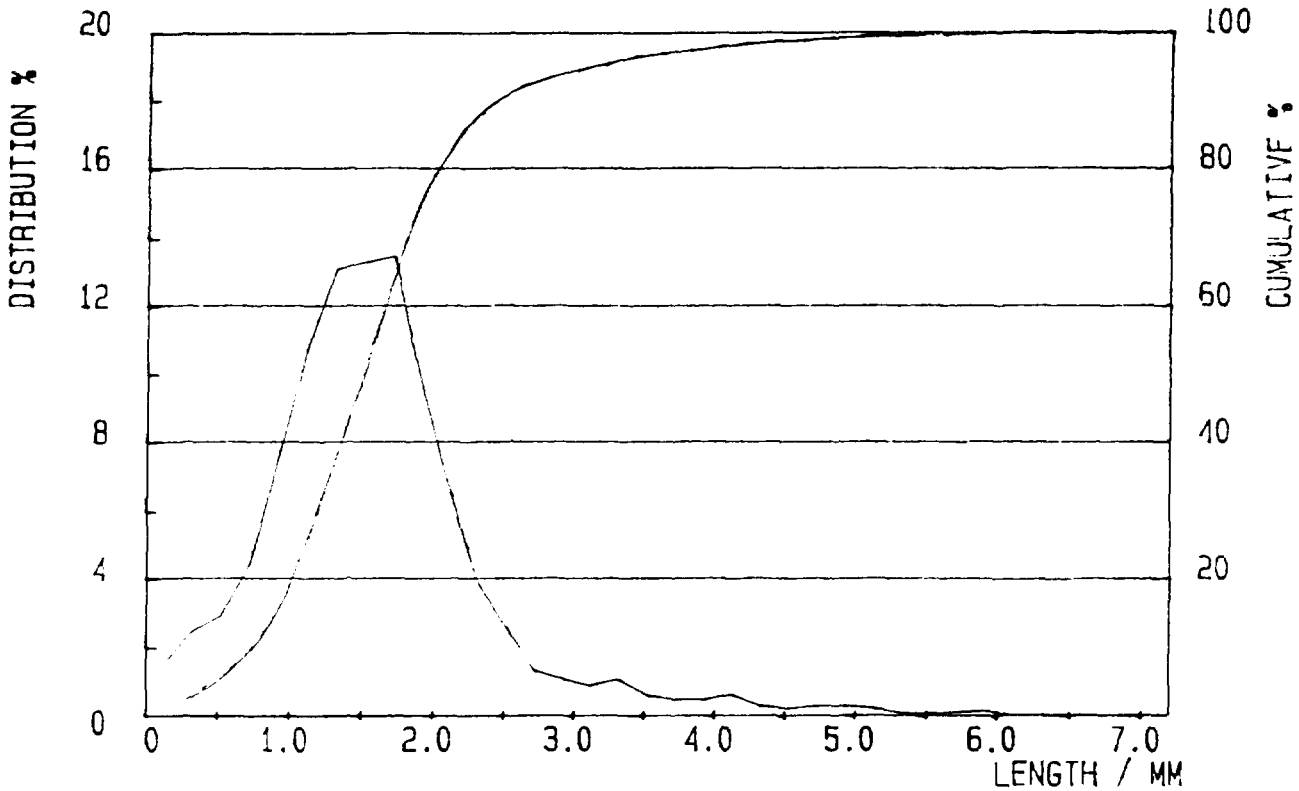
ARITHMETIC AV	1.24 mm	COARSENESS	0.100 mg/m
L WEIGHTED AV	1.68 mm	WOOD SPEC	0.0 %
W WEIGHTED AV	2.07 mm	CUSTOM /L VALUE OUT OF TABLE	

LENGTH 0.20 mm P= 8.90 % W= 0.57 %

KAJAANI FS-200 **SODA** 02-03-95 09: 16

WEIGHTED DISTRIBUTION

SAMPLE TITLE	N/14/95 P21B JUTA	SAMPLE FILE NO	008
SAMPLED	01-03-95	UPPER LIMIT	6.00
ANALYSED	02-03-95 09: 10	LOWER LIMIT	0.00
TOTAL FIBERS	32792	WEIGHT	9.12 mg



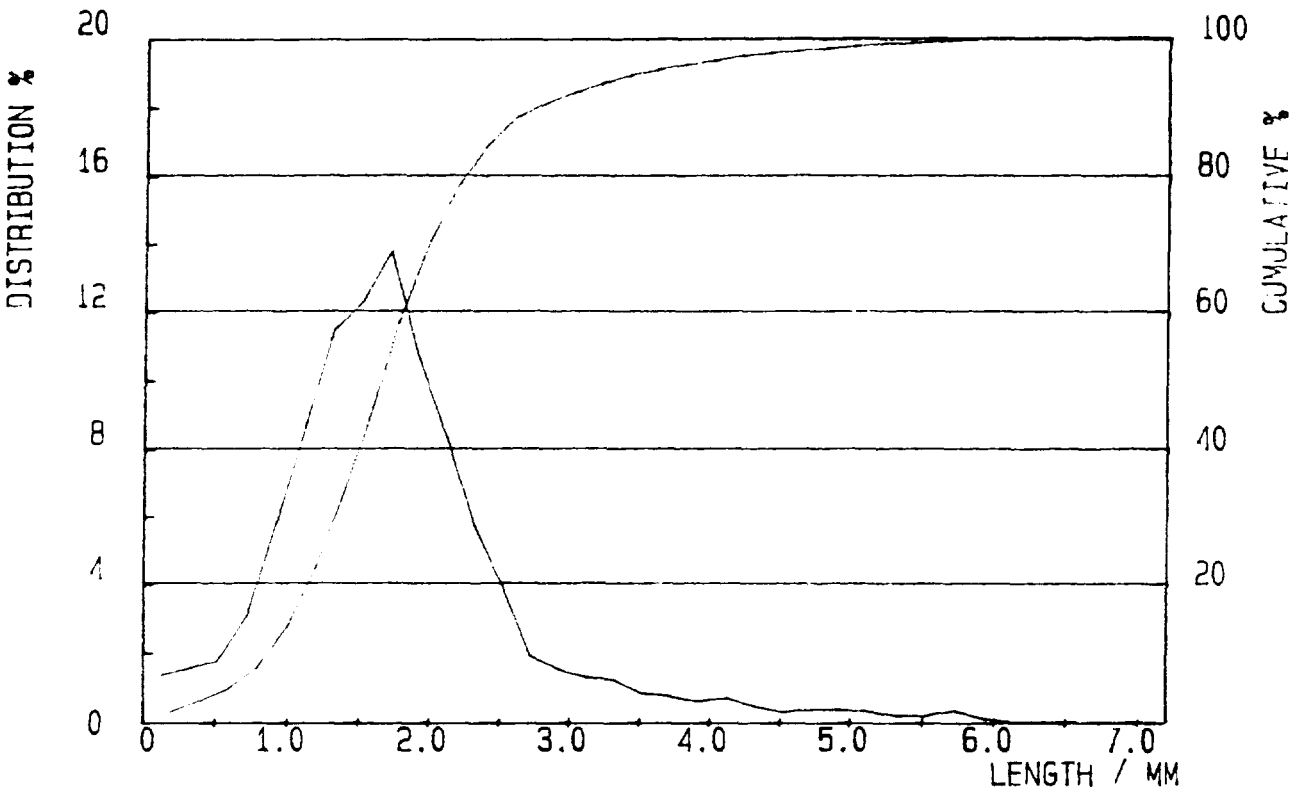
ARITHMETIC AV	1.02 mm	COARSENESS	0.106 mg/m
L WEIGHTED AV	1.58 mm	WOOD SPEC	0.0 %
W WEIGHTED AV	1.99 mm	CUSTOM /L VALUE OUT OF TABLE	

LENGTH 0.20 mm P= 18.36 % W= 1.54 %

KAJAANI FS-200 **SODA-AQ** 02-03-95 10:58

WEIGHTED DISTRIBUTION

SAMPLE TITLE	N/14/95 P22B JUTA	SAMPLE FILE NO	010
SAMPLED	01-03-95	UPPER LIMIT	6.00
ANALYSED	02-03-95 10:33	LOWER LIMIT	0.00
TOTAL FIBERS	30236	WEIGHT	9.11 mg



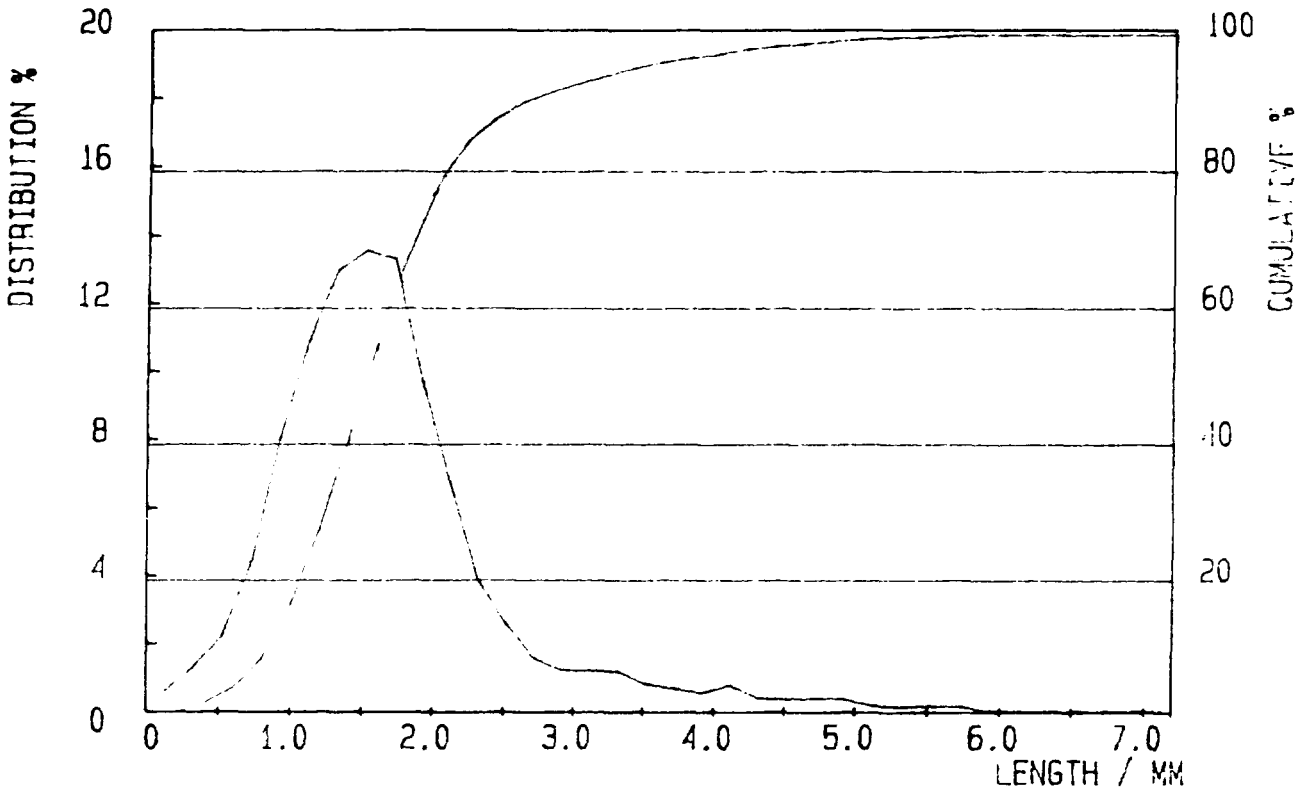
ARITHMETIC AV	1.14 mm	COARSENESS	0.101 mg/m
L WEIGHTED AV	1.76 mm	WOOD SPEC	0.0 %
W WEIGHTED AV	2.20 mm	CUSTOM /L VALUE OUT OF TABLE	

LENGTH 0.20 mm P= 19.42 % W= 1.34 %

KAJAANI FS-200 **ALKALINE SULPHITE-AQ** 06-03-95 08: 31

WEIGHTED DISTRIBUTION

SAMPLE TITLE	N/14/95 P 40 B JUTA	SAMPLE FILE NO	092
SAMPLED	06-03-95	UPPER LIMIT	6.00
ANALYSED	06-03-95 08: 25	LOWER LIMIT	0.00
TOTAL FIBERS	22355	WEIGHT	9.00 mg



ARITHMETIC AV	1.20 mm	COARSENESS	0.130 mg/m
L WEIGHTED AV	1.66 mm	WOOD SPEC	0.0 %
W WEIGHTED AV	2.07 mm	CUSTOM /L VALUE OUT OF TABLE	

LENGTH 0.20 mm P= 9.09 % W= 0.60 %

FIBRE DISTRIBUTION AND ANALYSIS OF BLEACHED JUTE PULP

WITH

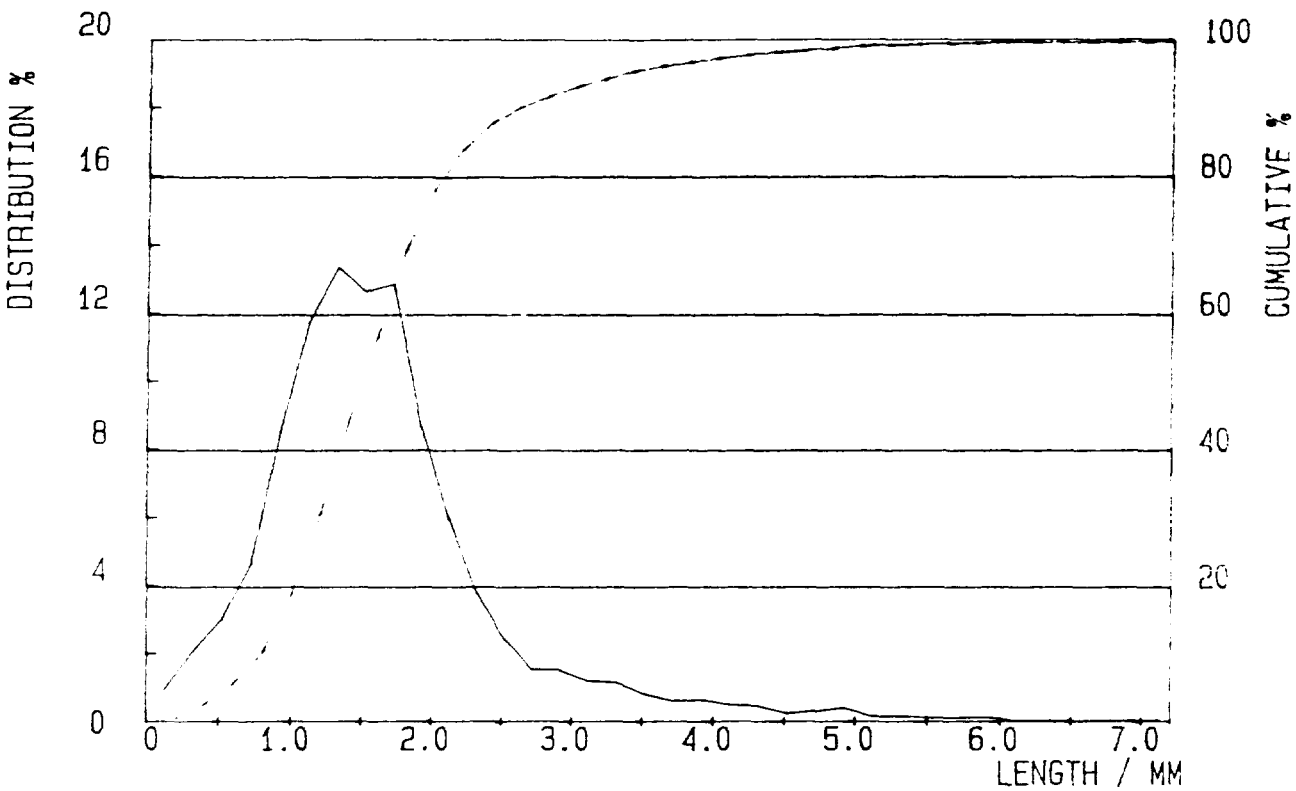
KAJAANI FS-200

BLEACHABILITY TEST ONLY

KAJAANI FS-200 17-03-95 11: 16

WEIGHTED DISTRIBUTION **KRAFT, BLEACHED**

SAMPLE TITLE	N14/95 P3 BELJ	SAMPLE FILE NO	005
SAMPLED	17-03-95	UPPER LIMIT	6.00
ANALYSED	17-03-95 11: 12	LOWER LIMIT	0.00
TOTAL FIBERS	30575	WEIGHT	9.06 mg



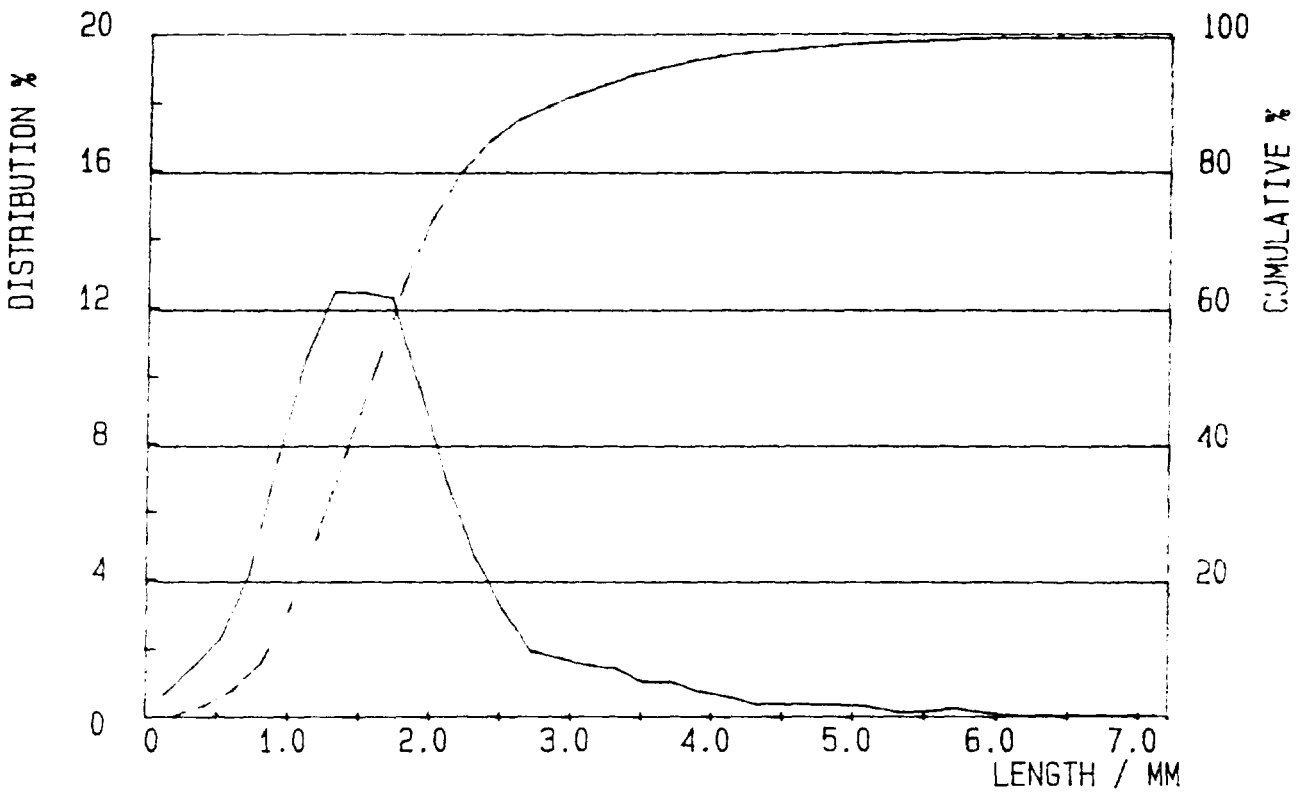
ARITHMETIC AV	1.10 mm	COARSENESS	0.102 mg/m
L WEIGHTED AV	1.60 mm	WOOD SPEC	0.0 %
W WEIGHTED AV	2.03 mm	CUSTOM /L VALUE OUT OF TABLE	

LENGTH 0.20 mm P= 11.61 % W= 0.91 %

KAJAANI FS-200 17-03-95 11:32

WEIGHTED DISTRIBUTION **KRAFT-AQ, BLEACHED**

SAMPLE TITLE	N14/95 P4 BELJ	SAMPLE FILE NO	012
SAMPLED	17-03-95	UPPER LIMIT	6.00
ANALYSED	17-03-95 11:30	LOWER LIMIT	0.00
TOTAL FIBERS	21993	WEIGHT	8.90 mg



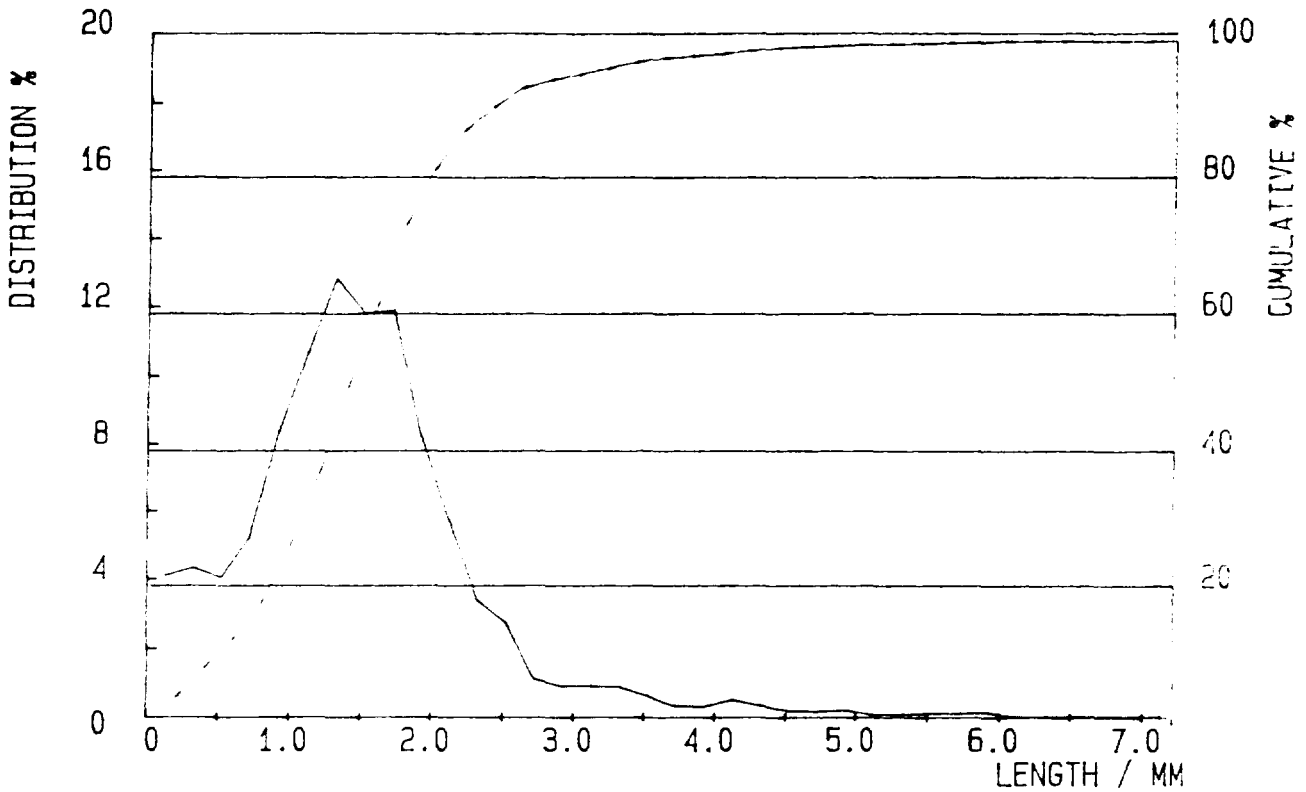
ARITHMETIC AV	1.21 mm	COARSENESS	0.129 mg/m
L WEIGHTED AV	1.71 mm	WOOD SPEC	0.0 %
W WEIGHTED AV	2.15 mm	CUSTOM /L VALUE OUT OF TABLE	

LENGTH 0.20 mm P= 9.47 % W= 0.64 %

KAJAANI FS-200 17-03-95 12:52

WEIGHTED DISTRIBUTION **SODA, BLEACHED**

SAMPLE TITLE	N14/95 P21 BELJ	SAMPLE FILE NO	014
SAMPLED	17-03-95	UPPER LIMIT	6.00
ANALYSED	17-03-95 12:04	LOWER LIMIT	0.00
TOTAL FIBERS	41422	WEIGHT	8.80 mg



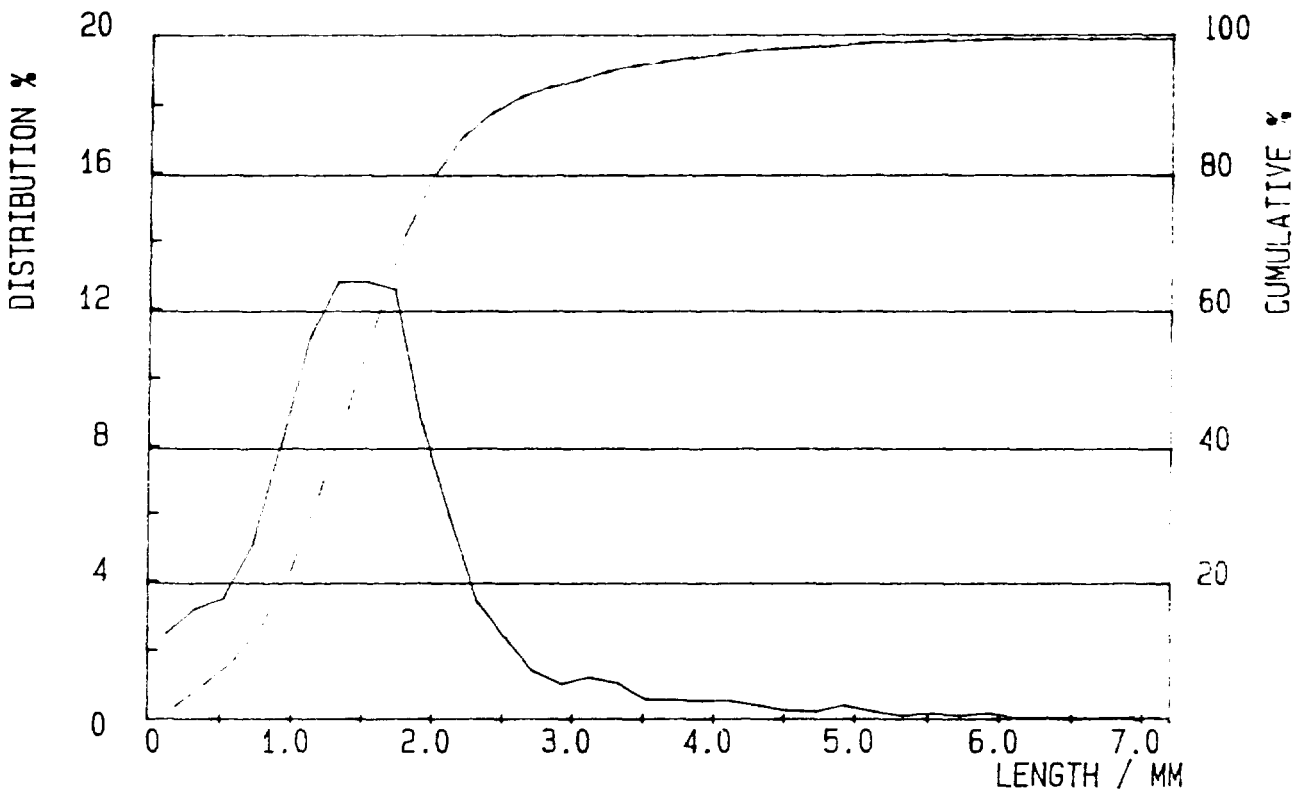
ARITHMETIC AV	0.72 mm	COARSENESS	0.109 mg/m
L WEIGHTED AV	1.46 mm	WOOD SPEC	0.0 %
W WEIGHTED AV	1.93 mm	CUSTOM /L	VALUE OUT OF TABLE

LENGTH 0.20 mm P= 36.16 % W= 4.08 %

KAJAANI FS-200 17-03-95 12:32

WEIGHTED DISTRIBUTION **SODA-AQ, BLEACHED**

SAMPLE TITLE	N14/95 P 22 BELJ	SAMPLE FILE NO	016
SAMPLED	16-03-95	UPPER LIMIT	6.00
ANALYSED	17-03-95 12:26	LOWER LIMIT	0.00
TOTAL FIBERS	36072	WEIGHT	8.72 mg



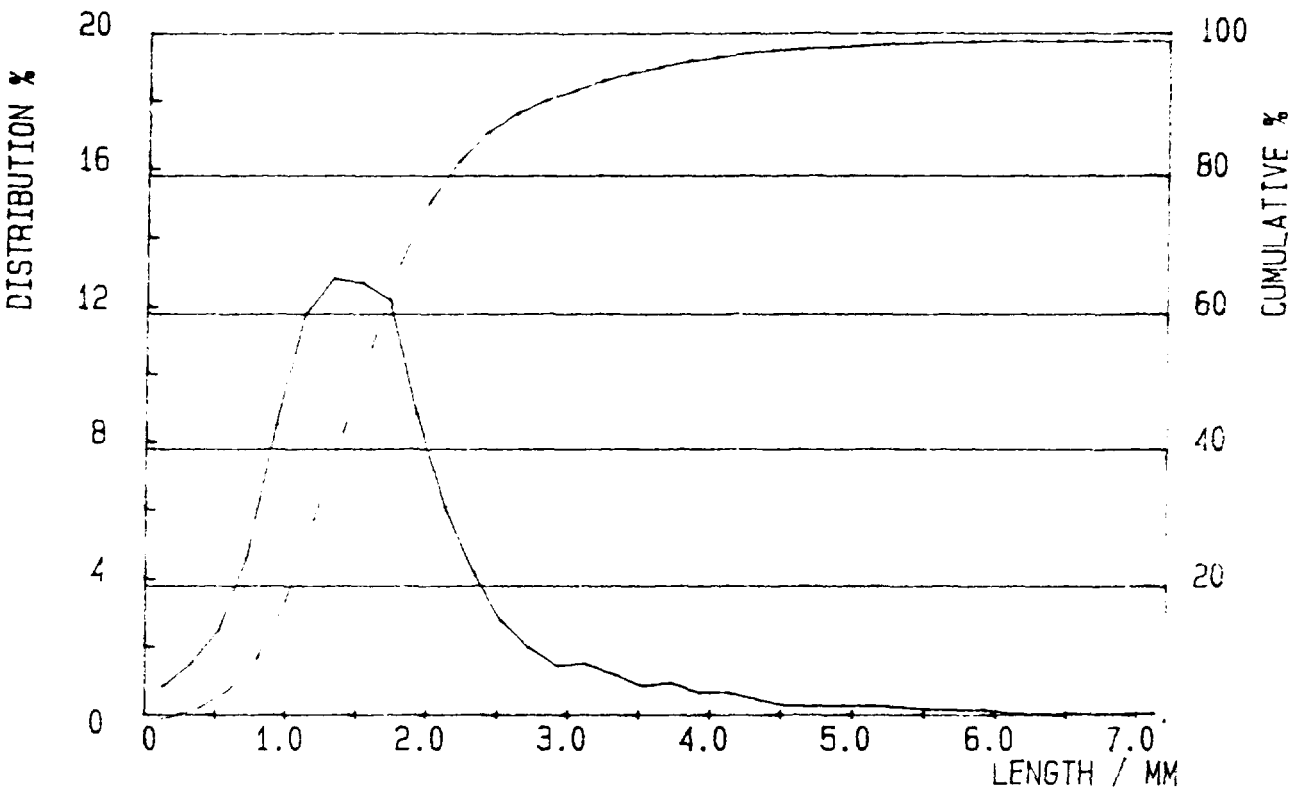
ARITHMETIC AV	0.88 mm	COARSENESS	0.108 mg/m
L WEIGHTED AV	1.54 mm	WOOD SPEC	0.0 %
W WEIGHTED AV	2.00 mm	CUSTOM /L VALUE OUT OF TABLE	

LENGTH 0.20 mm P= 25.93 % W= 2.45 %

KAJAANI FS-200 17-03-95 12: 47

WEIGHTED DISTRIBUTION **ALKALINE SULPHITE-AQ, BLEACHED**

SAMPLE TITLE	N14/95 P 40 BELJ	SAMPLE FILE NO	017
SAMPLED	16-03-95	UPPER LIMIT	6.00
ANALYSED	17-03-95 12: 46	LOWER LIMIT	0.00
TOTAL FIBERS	24070	WEIGHT	8.50 mg



ARITHMETIC AV	1.15 mm	COARSENESS	0.118 mg/m
L WEIGHTED AV	1.65 mm	WOOD SPEC	0.0 %
W WEIGHTED AV	2.08 mm	CUSTOM /L	VALUE OUT OF TABLE

LENGTH 0.20 mm P= 10.96 % W= 0.80 %

FIBRE DISTRIBUTION AND ANALYSIS OF BLEACHED JUTE PULP

WITH

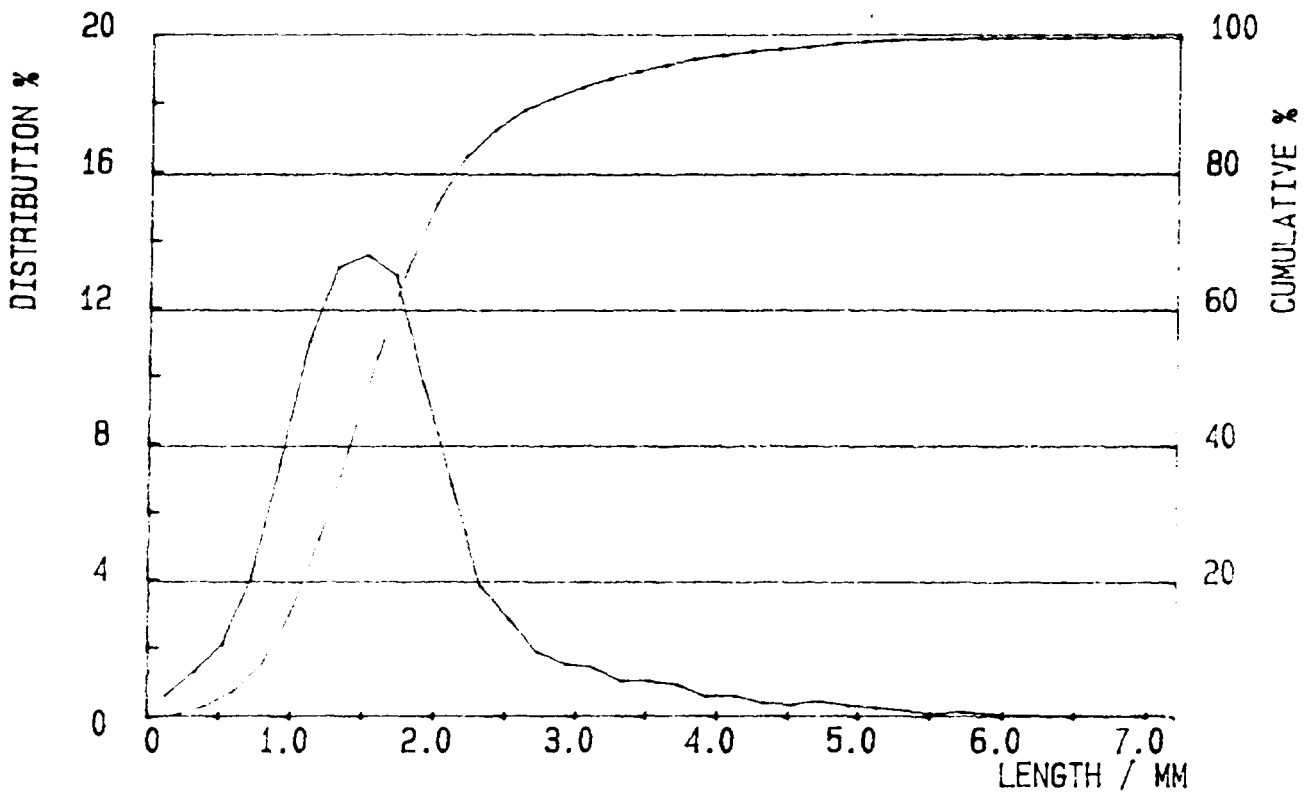
KAJAANI FS-200

BLEACHING TRIALS

KAJAANI FS-200 13-07-95 08: 14

WEIGHTED DISTRIBUTION

SAMPLE TITLE	N/14/95 1E C-E-H	SAMPLE FILE NO	045
SAMPLED	13-07-95	UPPER LIMIT	6.00
ANALYSED	13-07-95 08: 10	LOWER LIMIT	0.00
TOTAL FIBERS	21817	WEIGHT	7.83 mg

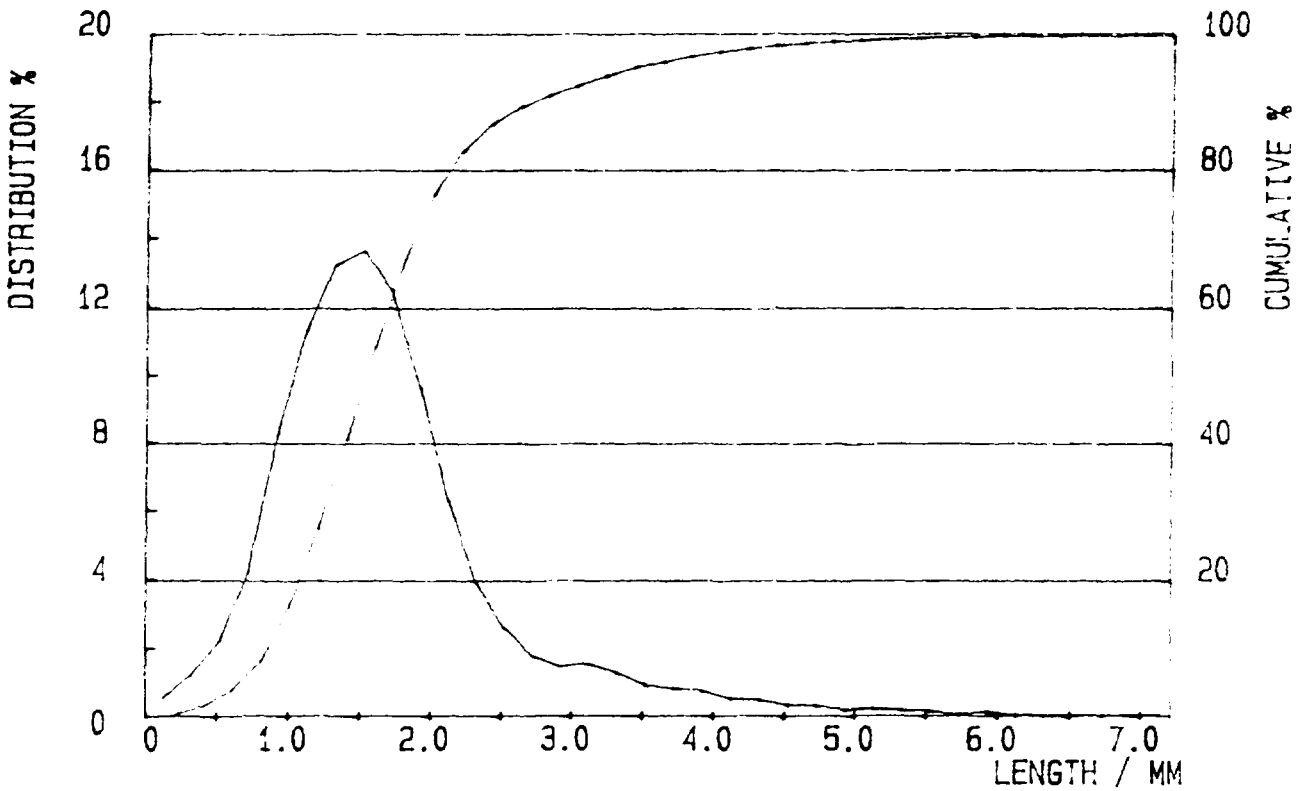


ARITHMETIC AV	1.23 mm	COARSENESS	0.105 mg/m
L WEIGHTED AV	1.67 mm	WOOD SPEC	0.0 %
W WEIGHTED AV	2.08 mm	CUSTOM /L VALUE OUT OF TABLE	
LENGTH 0.20 mm	P= 8.15 %	W= 0.57 %	

KAJAANI FS-200 13-07-95 08: 29

WEIGHTED DISTRIBUTION

SAMPLE TITLE	N/14/95 1E C-E-H	SAMPLE FILE NO	046
SAMPLED	13-07-95	UPPER LIMIT	6.00
ANALYSED	13-07-95 08: 24	LOWER LIMIT	0.00
TOTAL FIBERS	23270	WEIGHT	7.83 mg

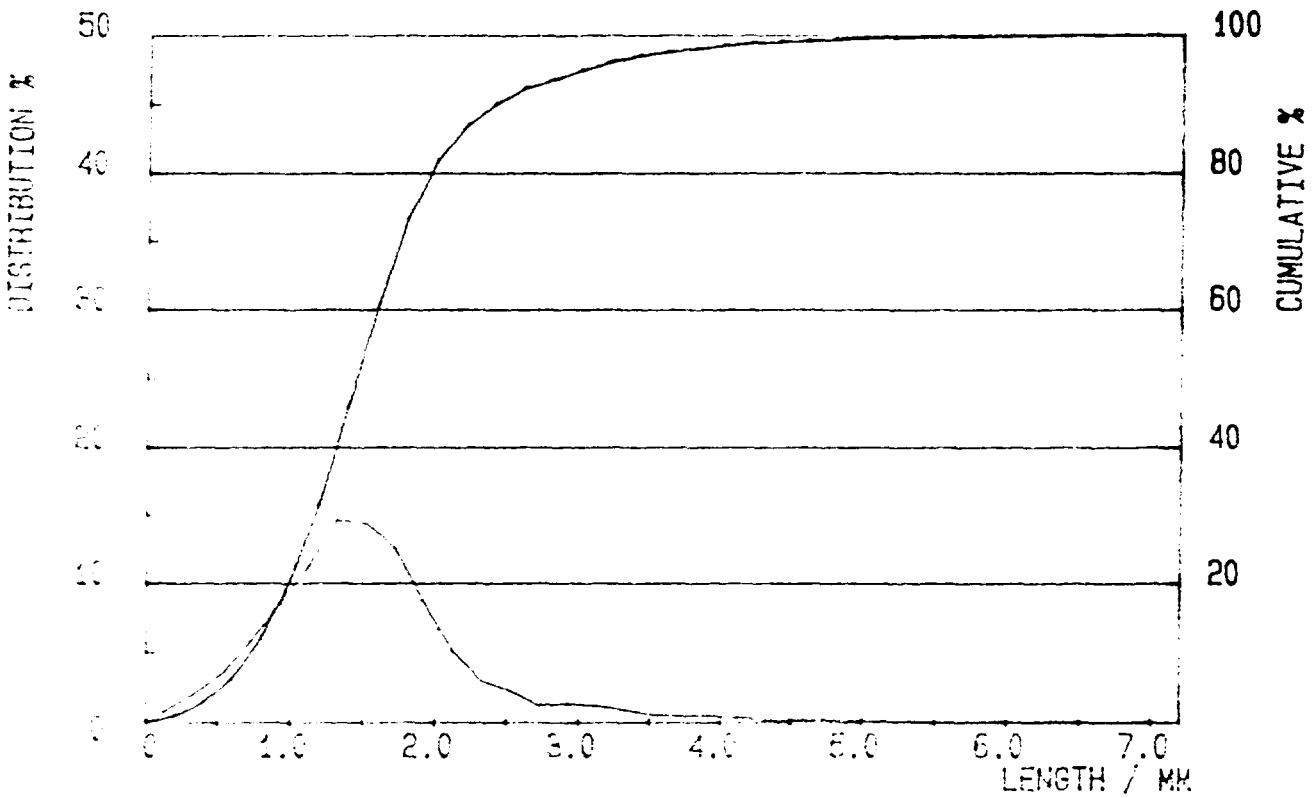


ARITHMETIC AV	1.22 mm	COARSENESS	0.100 mg/m
L WEIGHTED AV	1.66 mm	WOOD SPEC	0.0 %
W WEIGHTED AV	2.06 mm	CUSTOM /L VALUE OUT OF TABLE	
LENGTH 0.20 mm	P= 7.91 %	W= 0.52 %	

KAJAANI FS-200 21-09-95 15: 20

WEIGHTED DISTRIBUTION

SAMPLE TITLE	C-E-H	SAMPLE FILE NO	026
SAMPLED	21-09-95	UPPER LIMIT	7.20
ANALYSED	21-09-95 15: 18	LOWER LIMIT	0.00
TOTAL FIBERS	21569	WEIGHT	5.67 mg

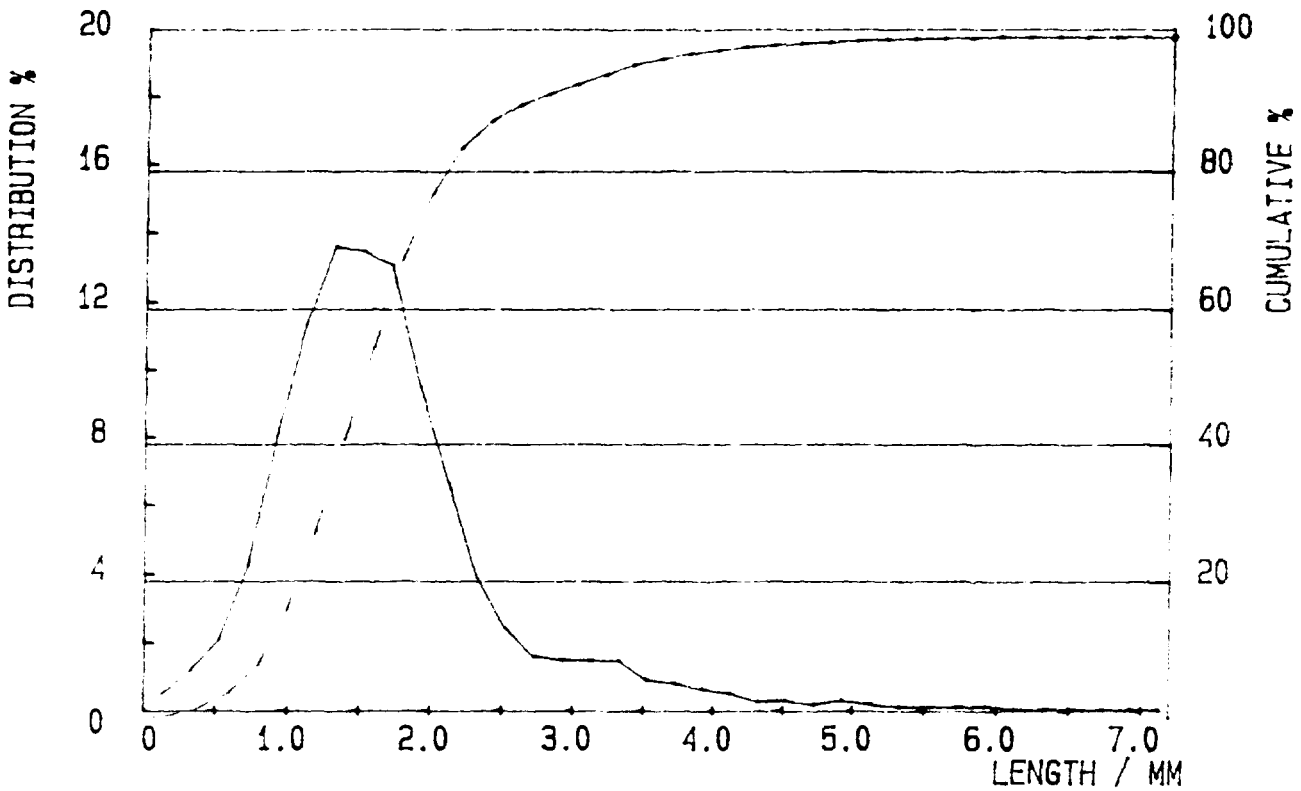


ARITHMETIC AV 1.09 mm COARSENESS 0.100 mg/m
L WEIGHTED AV 1.54 mm
W WEIGHTED AV 1.93 mm
LENGTH 0.20 mm P= 9.95 % W= 0.81 %

KAJAANI FS-200 13-07-95 09: 13

WEIGHTED DISTRIBUTION

SAMPLE TITLE	N/14/95 2C C-EP-H	SAMPLE FILE NO	048
SAMPLED	13-07-95	UPPER LIMIT	6.00
ANALYSED	13-07-95 08: 53	LOWER LIMIT	0.00
TOTAL FIBERS	19255	WEIGHT	7.64 mg



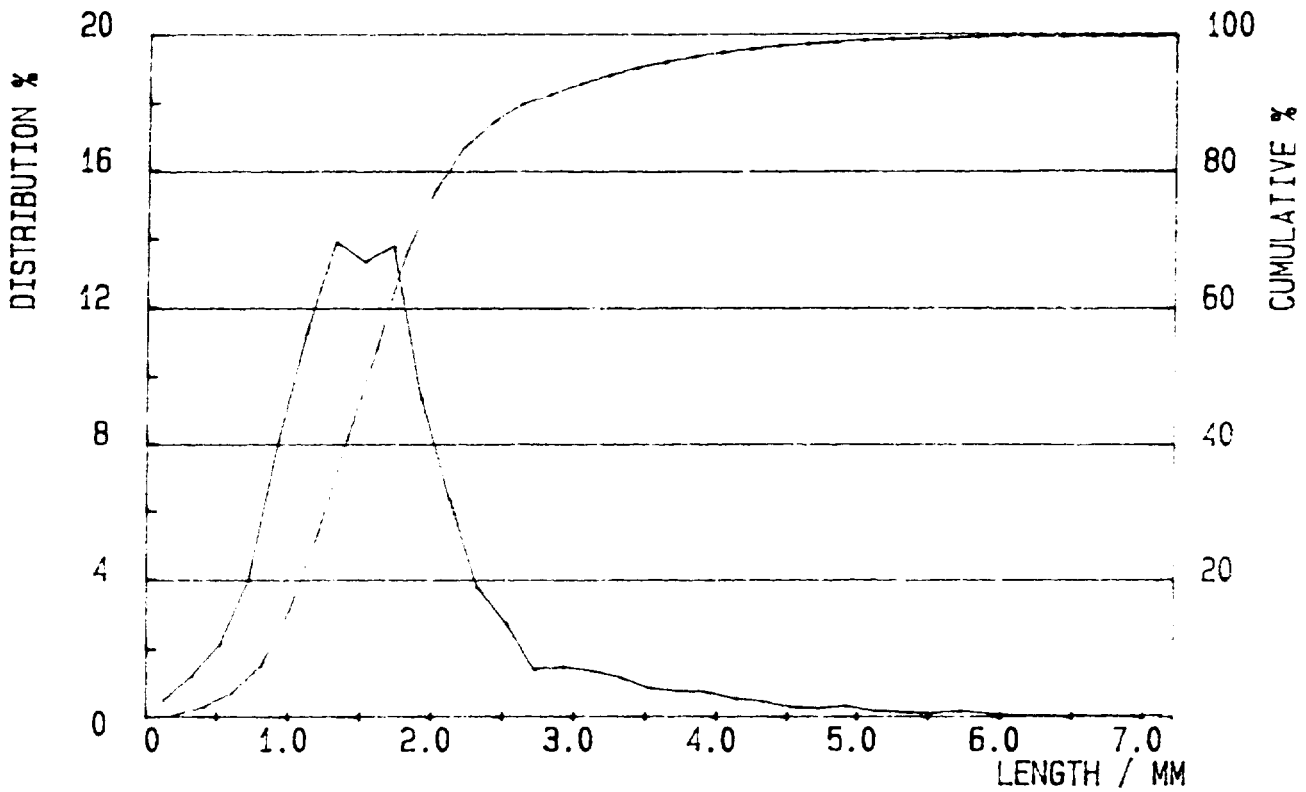
ARITHMETIC AV	1.23 mm	COARSENESS	0.117 mg/m
L WEIGHTED AV	1.65 mm	WOOD SPEC	0.0 %
W WEIGHTED AV	2.03 mm	CUSTOM /L	VALUE OUT OF TABLE

LENGTH 0.20 mm P= 6.90 % W= 0.47 %

KAJAANI FS-200 13-07-95 08: 44

WEIGHTED DISTRIBUTION

SAMPLE TITLE	N/14/95 2C C-EP-H	SAMPLE FILE NO	047
SAMPLED	13-07-95	UPPER LIMIT	6.00
ANALYSED	13-07-95 08: 41	LOWER LIMIT	0.00
TOTAL FIBERS	20819	WEIGHT	7.64 mg

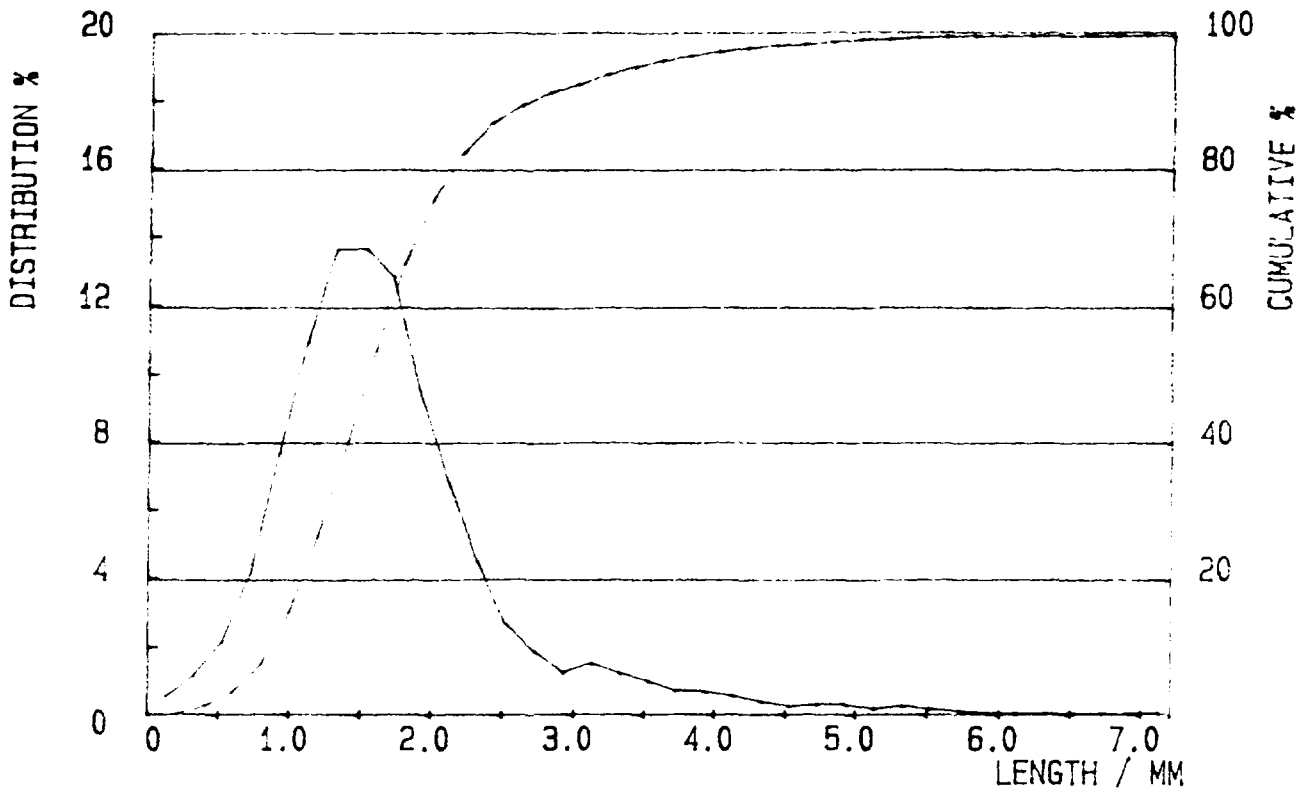


ARITHMETIC AV	1.24 mm	COARSENESS	0.106 mg/m
L WEIGHTED AV	1.65 mm	WOOD SPEC	0.0 %
W WEIGHTED AV	2.04 mm	CUSTOM /L VALUE OUT OF TABLE	
LENGTH 0.20 mm	P= 6.79 %	W= 0.46 %	

KAJAANI FS-200 13-07-95 09:26

WEIGHTED DISTRIBUTION

SAMPLE TITLE	N/14/95 2C C-EP-H	SAMPLE FILE NO	049
SAMPLED	13-07-95	UPPER LIMIT	6.00
ANALYSED	13-07-95 09:23	LOWER LIMIT	0.00
TOTAL FIBERS	21163	WEIGHT	7.64 mg

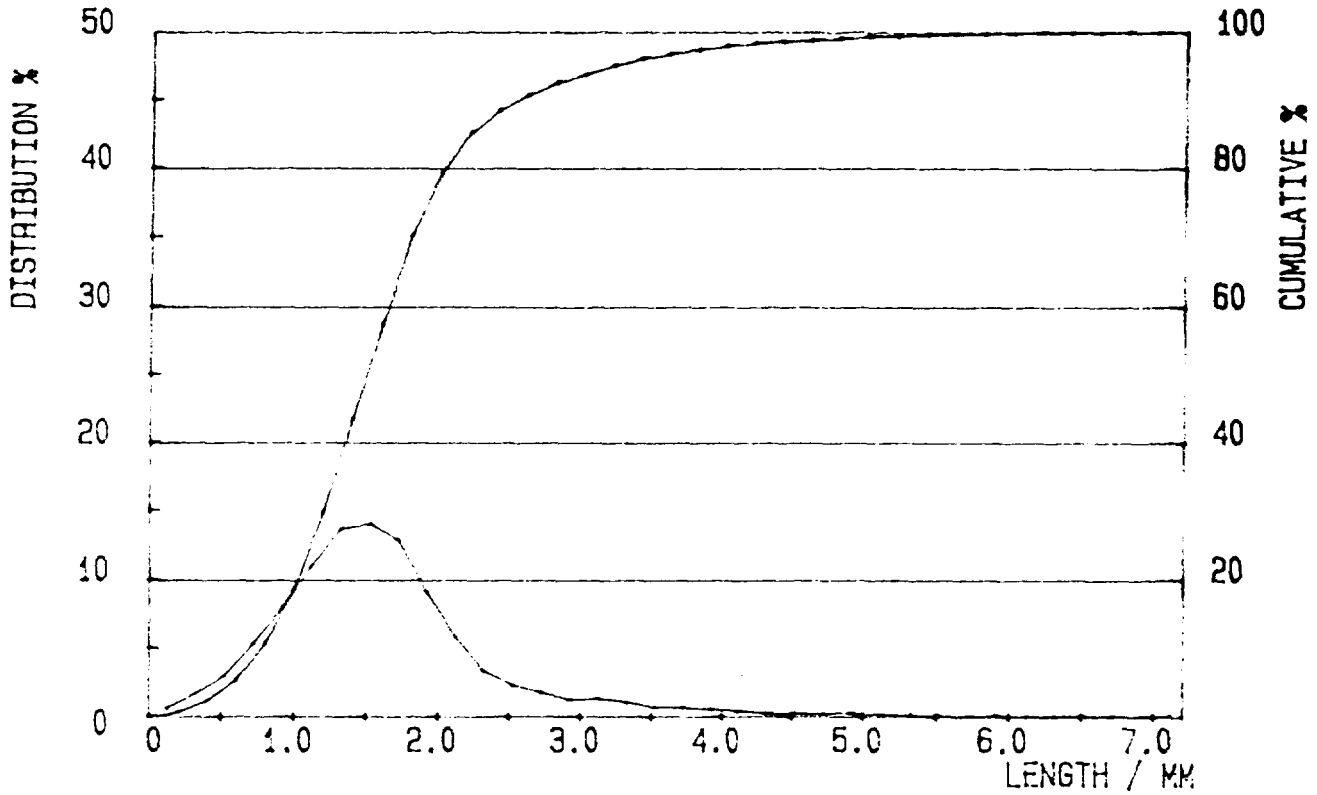


ARITHMETIC AV	1.24 mm	COARSENESS	0.105 mg/m
L WEIGHTED AV	1.66 mm	WOOD SPEC	0.0 %
W WEIGHTED AV	2.06 mm	CUSTOM /L VALUE OUT OF TABLE	
LENGTH 0.20 mm	P= 7.29 %	W= 0.50 %	

KAJAANI FS-200 22-09-95 09:59

WEIGHTED DISTRIBUTION

SAMPLE TITLE	C-EP-H	SAMPLE FILE NO	027
SAMPLED	22-09-95	UPPER LIMIT	7.20
ANALYSED	22-09-95 09:54	LOWER LIMIT	0.00
TOTAL FIBERS	21295	WEIGHT	6.30 mg

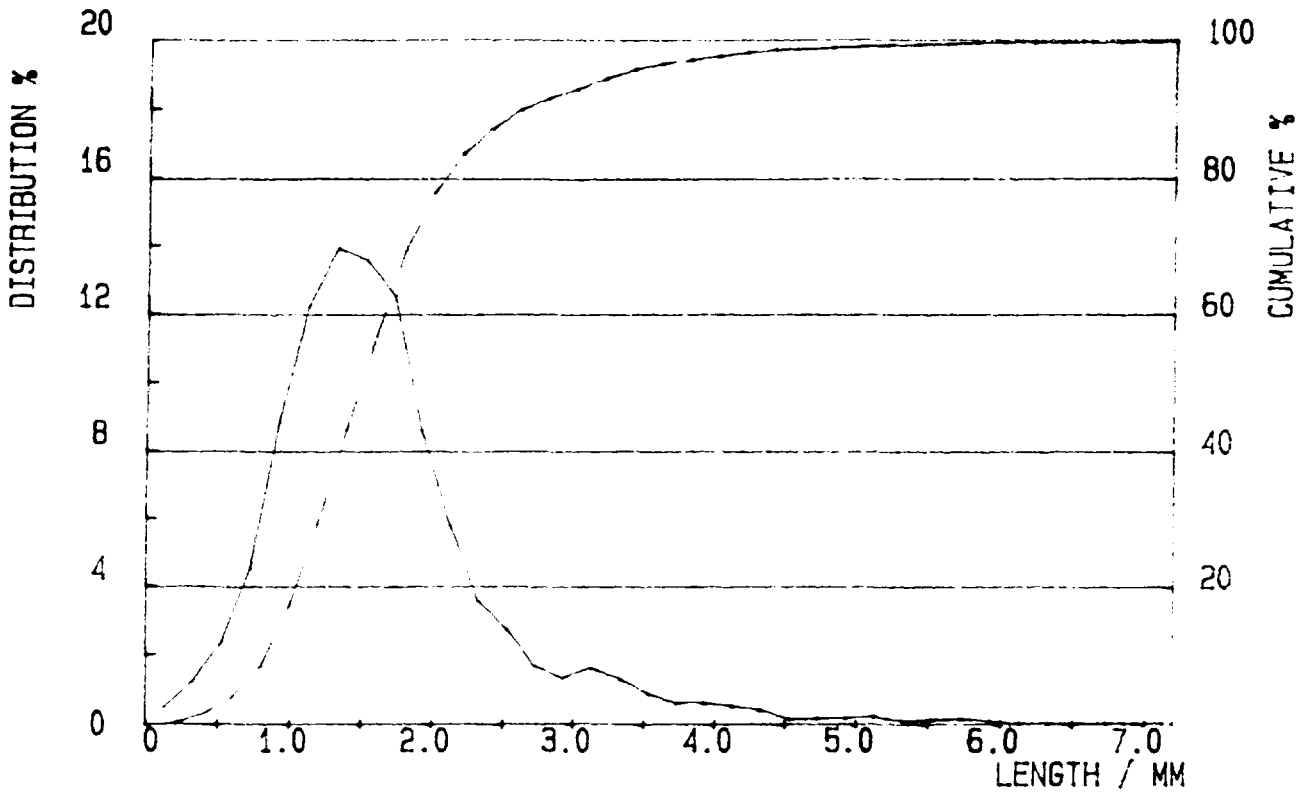


ARITHMETIC AV 1.15 mm COARSENESS 0.106 mg/m
L WEIGHTED AV 1.60 mm
W WEIGHTED AV 2.01 mm
LENGTH 0.20 mm P= 8.32 % W= 0.64 %

KAJAANI FS-200 13-07-95 10:01

WEIGHTED DISTRIBUTION

SAMPLE TITLE	N/14/95 3C 0-C-EO-H	SAMPLE FILE NO	052
SAMPLED	13-07-95	UPPER LIMIT	6.00
ANALYSED	13-07-95 09:59	LOWER LIMIT	0.00
TOTAL FIBERS	15411	WEIGHT	7.43 mg



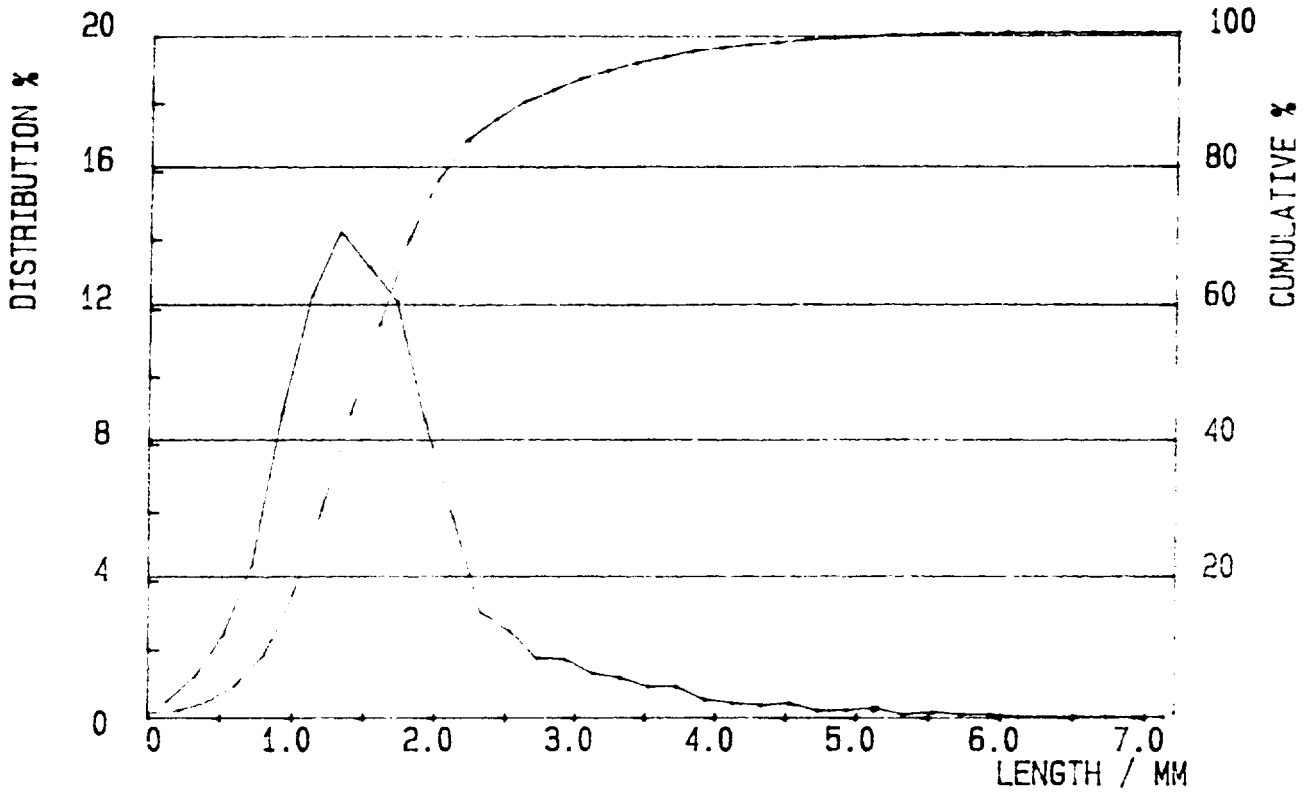
ARITHMETIC AV	1.21 mm	COARSENESS	0.144 mg/m
L WEIGHTED AV	1.62 mm	WOOD SPEC	0.0 %
W WEIGHTED AV	2.01 mm	CUSTOM /L VALUE OUT OF TABLE	

LENGTH 0.20 mm P= 6.50 % W= 0.45 %

KAJAANI FS-200 13-07-95 09:50

WEIGHTED DISTRIBUTION

SAMPLE TITLE	N/14/95 3C 0-C-E0-H	SAMPLE FILE NO	051
SAMPLED	13-07-95	UPPER LIMIT	6.00
ANALYSED	13-07-95 09:48	LOWER LIMIT	0.00
TOTAL FIBERS	15233	WEIGHT	7.43 mg



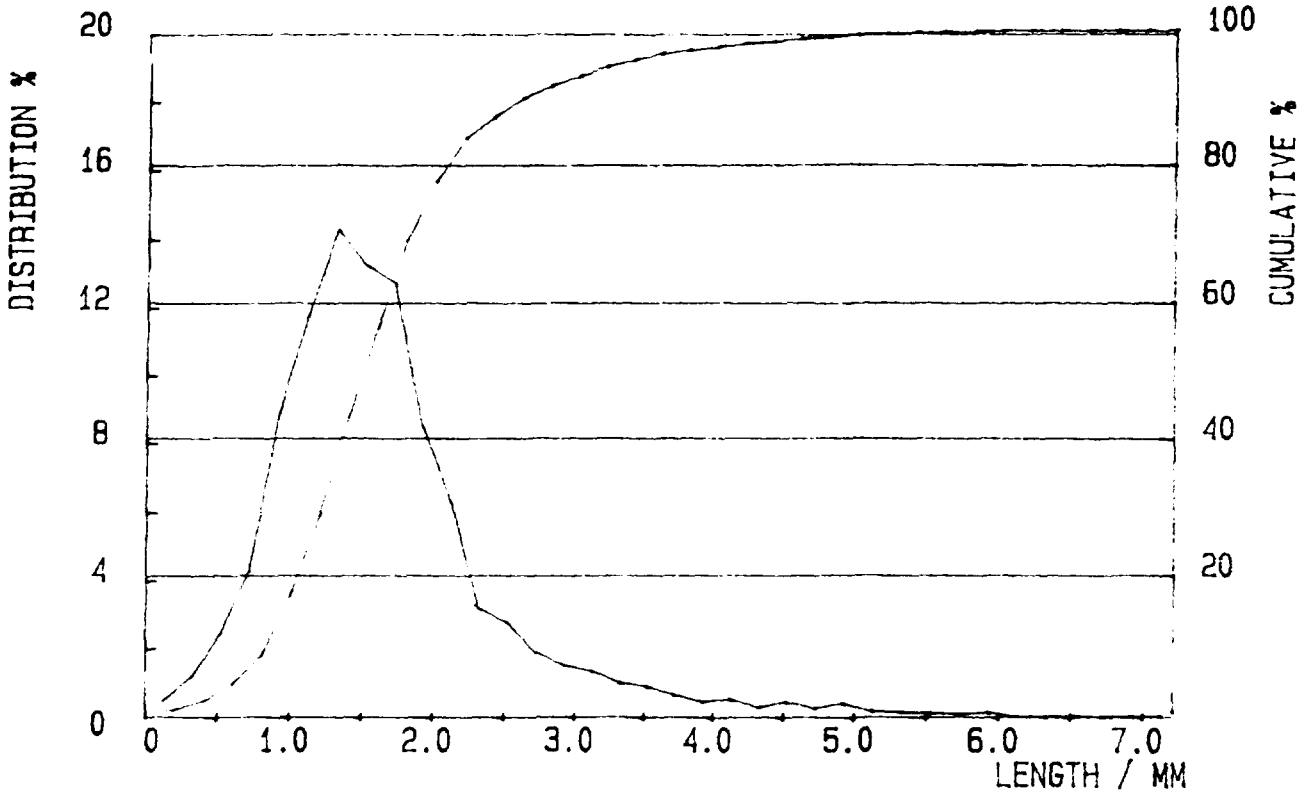
ARITHMETIC AV	1.21 mm	COARSENESS	0.146 mg/m
L WEIGHTED AV	1.62 mm	WOOD SPEC	0.0 %
W WEIGHTED AV	2.03 mm	CUSTOM /L VALUE OUT OF TABLE	

LENGTH 0.20 mm P= 6.20 % W= 0.44 %

KAJAANI FS-200 13-07-95 09:38

WEIGHTED DISTRIBUTION

SAMPLE TITLE	N/14/95 3C 0-C-E0-H	SAMPLE FILE NO	050
SAMPLED	13-07-95	UPPER LIMIT	6.00
ANALYSED	13-07-95 09:36	LOWER LIMIT	0.00
TOTAL FIBERS	14990	WEIGHT	7.43 mg

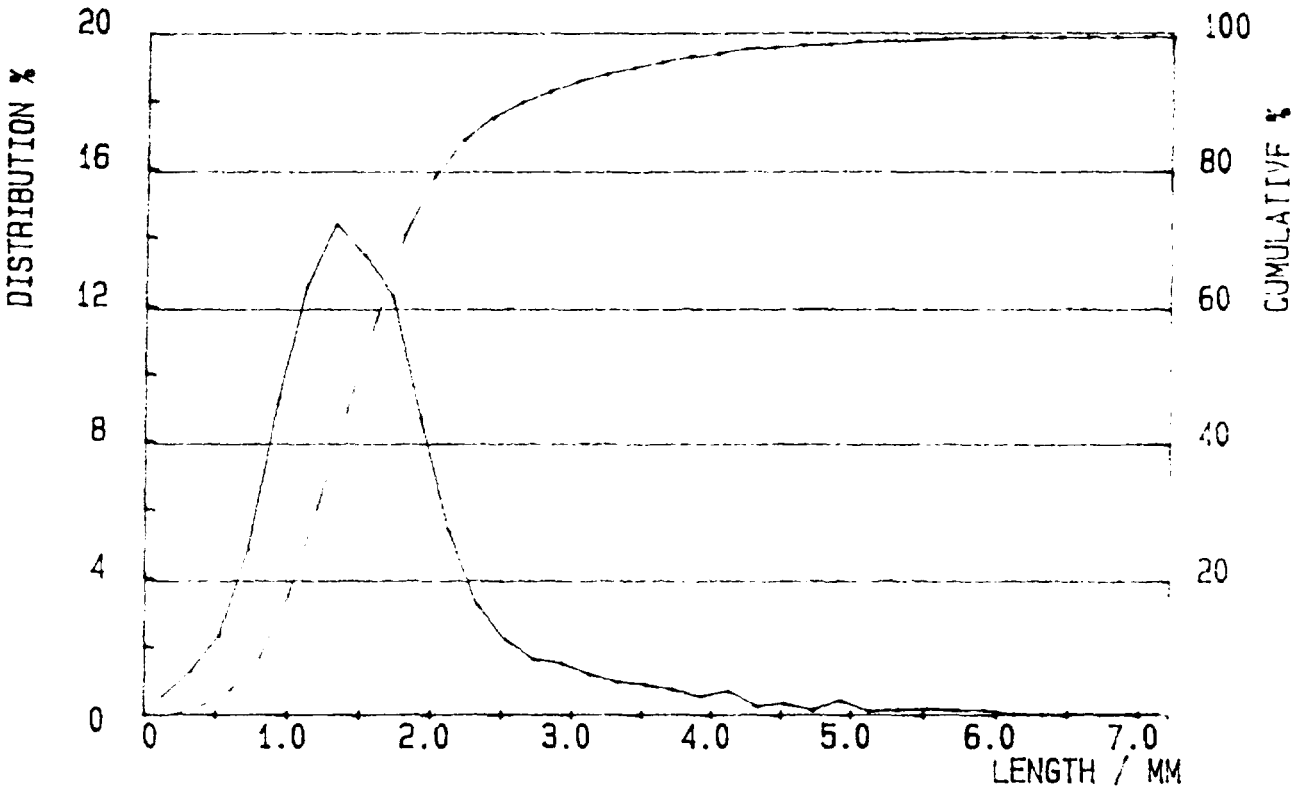


ARITHMETIC AV	1.21 mm	COARSENESS	0.149 mg/m
L WEIGHTED AV	1.63 mm	WOOD SPEC	0.0 %
W WEIGHTED AV	2.04 mm	CUSTOM /L VALUE OUT OF TABLE	
LENGTH 0.20 mm	P= 6.65 %	W= 0.46 %	

KAJAANI FS-200 14-07-95 08:32

WEIGHTED DISTRIBUTION

SAMPLE TITLE	N/14/95 4C D-E-D-D2	SAMPLE FILE NO	054
SAMPLED	14-07-95	UPPER LIMIT	6.00
ANALYSED	14-07-95 08:29	LOWER LIMIT	0.00
TOTAL FIBERS	21634	WEIGHT	7.88 mg

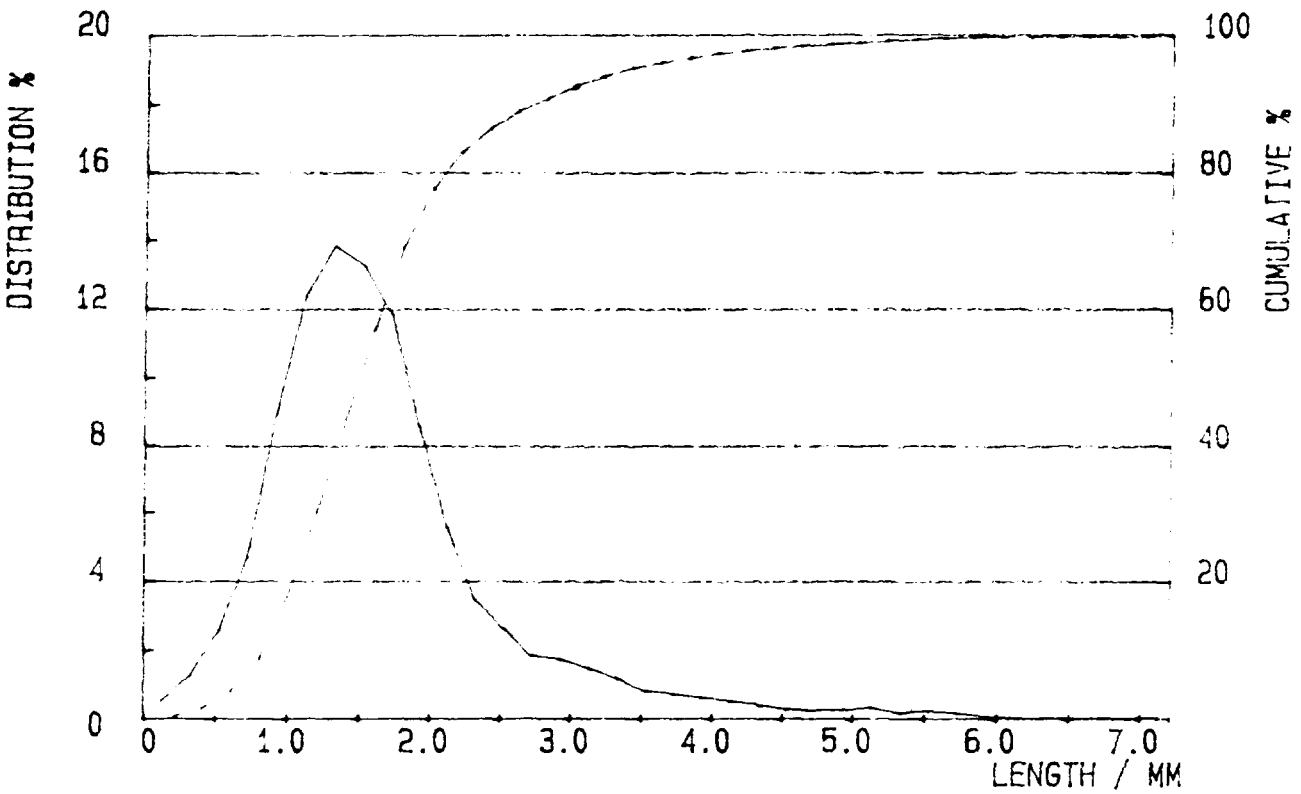


ARITHMETIC AV	1.19 mm	COARSENESS	0.110 mg/m
L WEIGHTED AV	1.60 mm	WOOD SPEC	0.0 %
W WEIGHTED AV	2.02 mm	CUSTOM /L VALUE OUT OF TABLE	
LENGTH 0.20 mm	P= 6.84 %	W= 0.50 %	

KAJAANI FS-200 14-07-95 08: 19

WEIGHTED DISTRIBUTION

SAMPLE TITLE	N/14/95 4C D-E-D-D2	SAMPLE FILE NO	053
SAMPLED	14-07-95	UPPER LIMIT	6.00
ANALYSED	14-07-95 08: 17	LOWER LIMIT	0.00
TOTAL FIBERS	21967	WEIGHT	7.88 mg



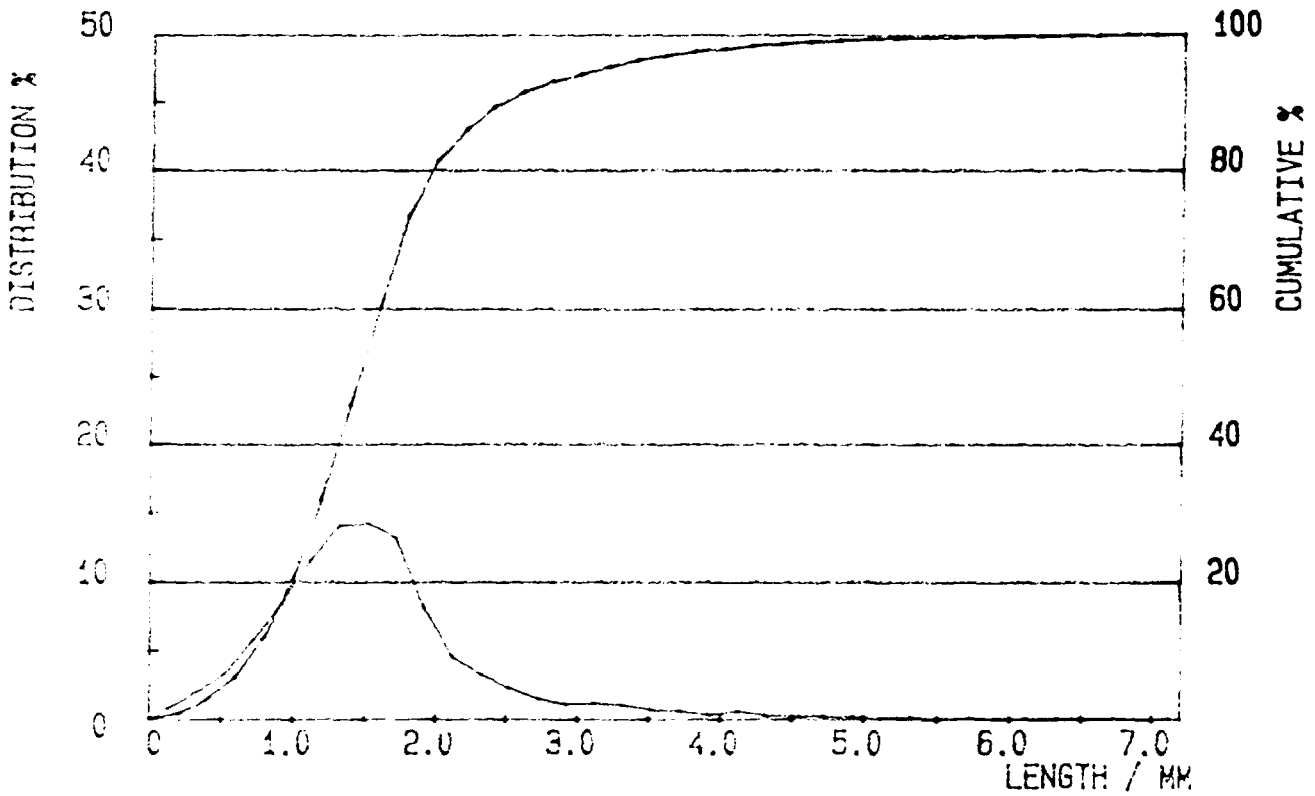
ARITHMETIC AV	1.20 mm	COARSENESS	0.108 mg/m
L WEIGHTED AV	1.63 mm	WOOD SPEC	0.0 %
W WEIGHTED AV	2.06 mm	CUSTOM /L VALUE OUT OF TABLE	

LENGTH 0.20 mm P= 6.67 % W= 0.50 %

KAJAANI FS-200 21-09-95 15:06

WEIGHTED DISTRIBUTION

SAMPLE TITLE	D-E-D	SAMPLE FILE NO	025
SAMPLED	21-09-95	UPPER LIMIT	7.20
ANALYSED	21-09-95 15:04	LOWER LIMIT	0.00
TOTAL FIBERS	22921	WEIGHT	6.39 mg

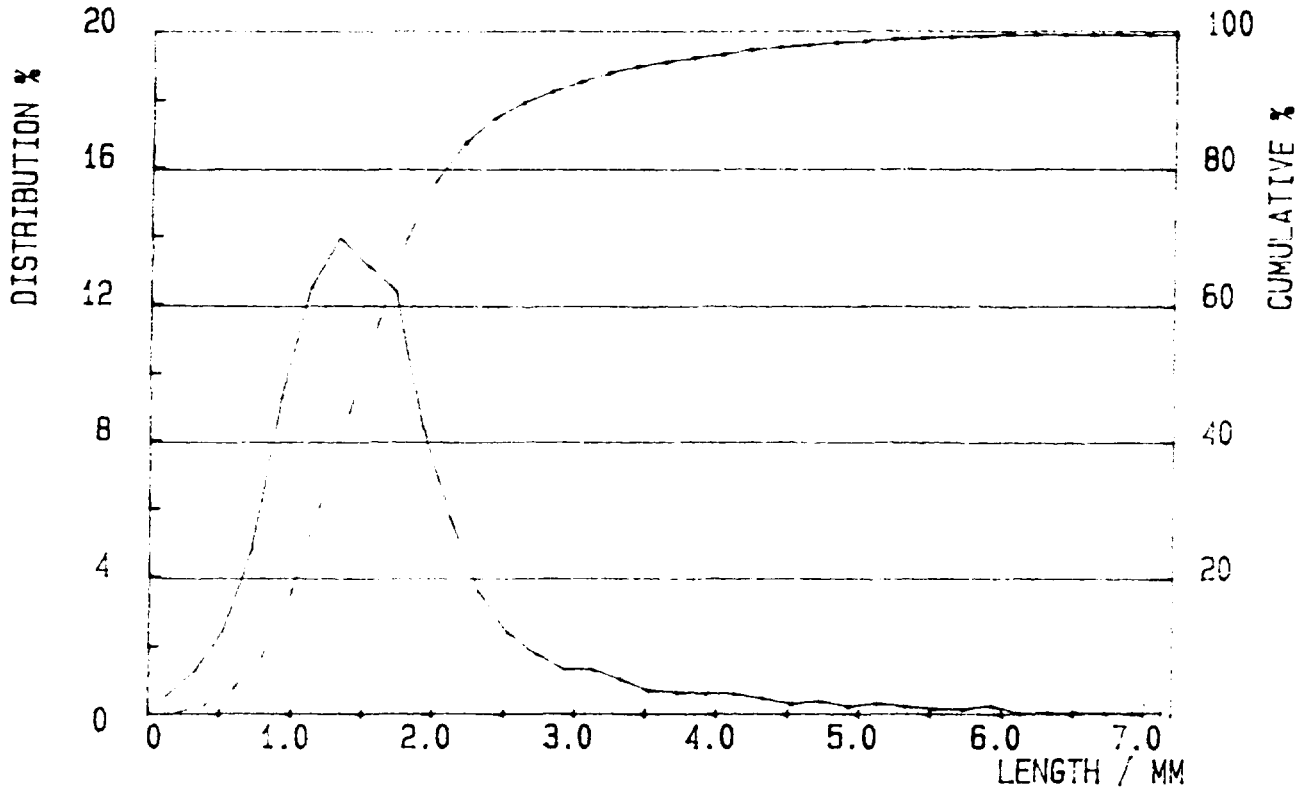


ARITHMETIC AV 1.10 mm COARSENESS 0.106 mg/m
L WEIGHTED AV 1.56 mm
W WEIGHTED AV 1.99 mm
LENGTH 0.20 mm P= 9.69 % W= 0.78 %

KAJAANI FS-200 14-07-95 09:23

WEIGHTED DISTRIBUTION

SAMPLE TITLE	N/14/95-5B-0-D-E0-DD	SAMPLE FILE NO	056
SAMPLED	14-07-95	UPPER LIMIT	6.00
ANALYSED	14-07-95 08:54	LOWER LIMIT	0.00
TOTAL FIBERS	18945	WEIGHT	7.67 mg



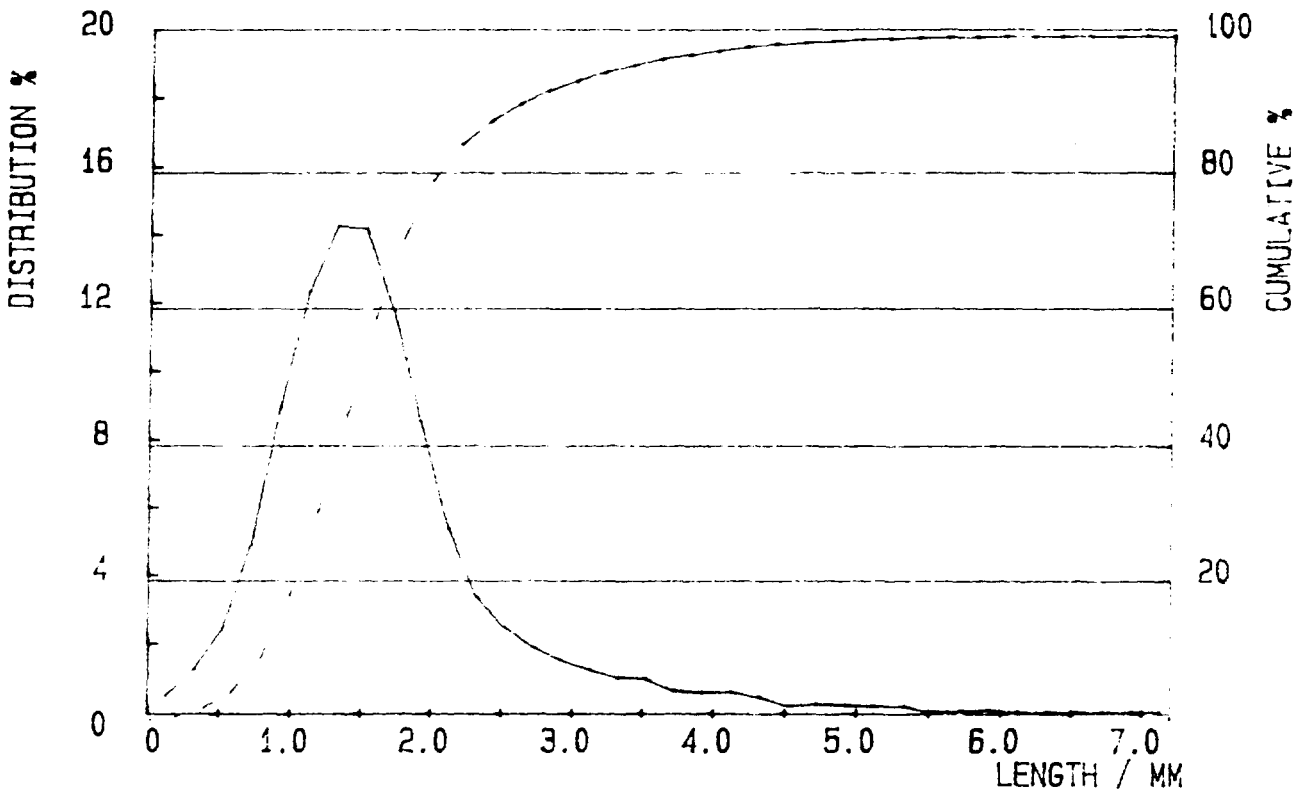
ARITHMETIC AV	1.20 mm	COARSENESS	0.121 mg/m
L WEIGHTED AV	1.62 mm	WOOD SPEC	0.0 %
W WEIGHTED AV	2.06 mm	CUSTOM /L VALUE OUT OF TABLE	

LENGTH 0.20 mm P= 6.78 % W= 0.49 %

KAJAANI FS-200 14-07-95 08: 57

WEIGHTED DISTRIBUTION

SAMPLE TITLE	N/14/95-58-0-D-E0-DD	SAMPLE FILE NO	055
SAMPLED	14-07-95	UPPER LIMIT	6.00
ANALYSED	14-07-95 08: 43	LOWER LIMIT	0.00
TOTAL FIBERS	18498	WEIGHT	7.67 mg



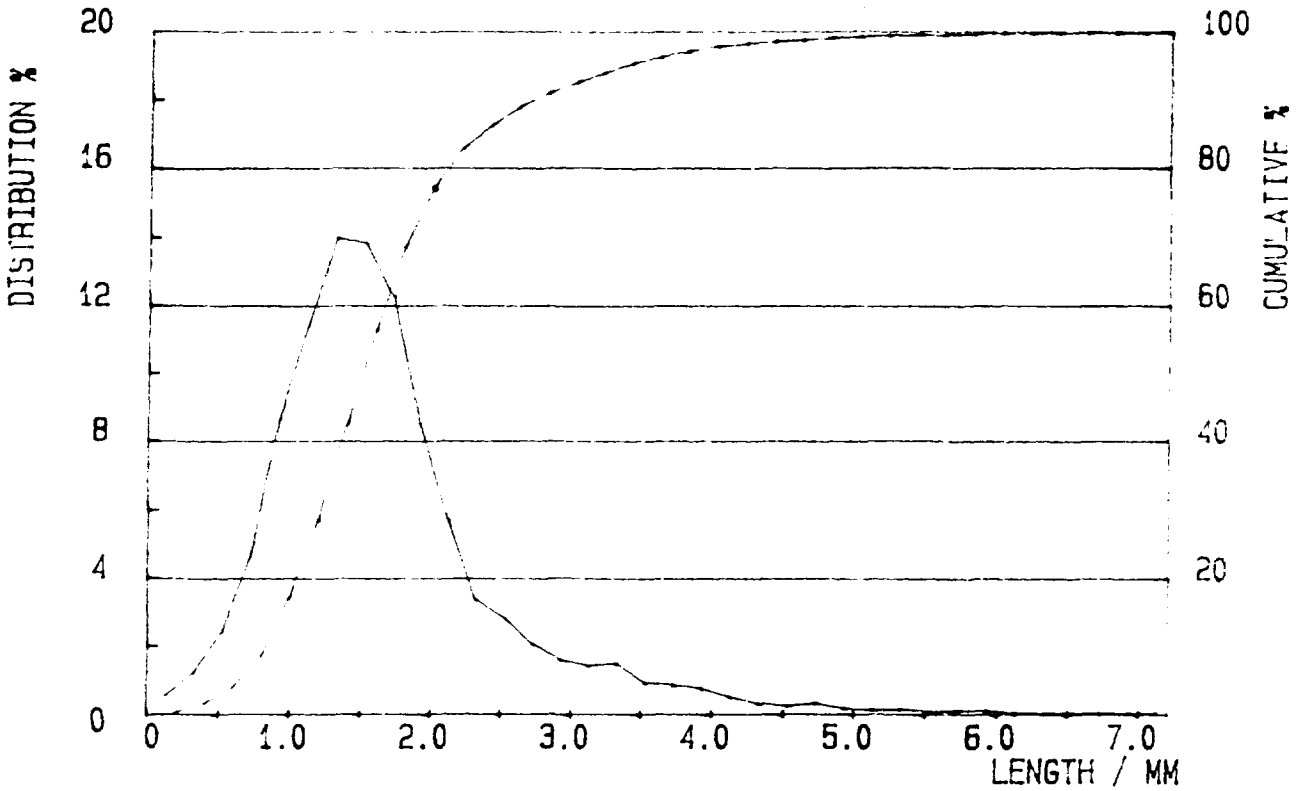
ARITHMETIC AV 1.20 mm
L WEIGHTED AV 1.60 mm
W WEIGHTED AV 2.00 mm
LENGTH 0.20 mm P= 6.48 % W= 0.49 %

COARSENESS 0.125 mg/m
WOOD SPEC 0.0 %
CUSTOM /L VALUE OUT OF TABLE

KAJAANI FS-200 14-07-95 09:38

WEIGHTED DISTRIBUTION

SAMPLE TITLE	N/14/95-6C-0-Q-EOP-P	SAMPLE FILE NO	057
SAMPLED	14-07-95	UPPER LIMIT	6.00
ANALYSED	14-07-95 09:35	LOWER LIMIT	0.00
TOTAL FIBERS	18535	WEIGHT	7.49 mg



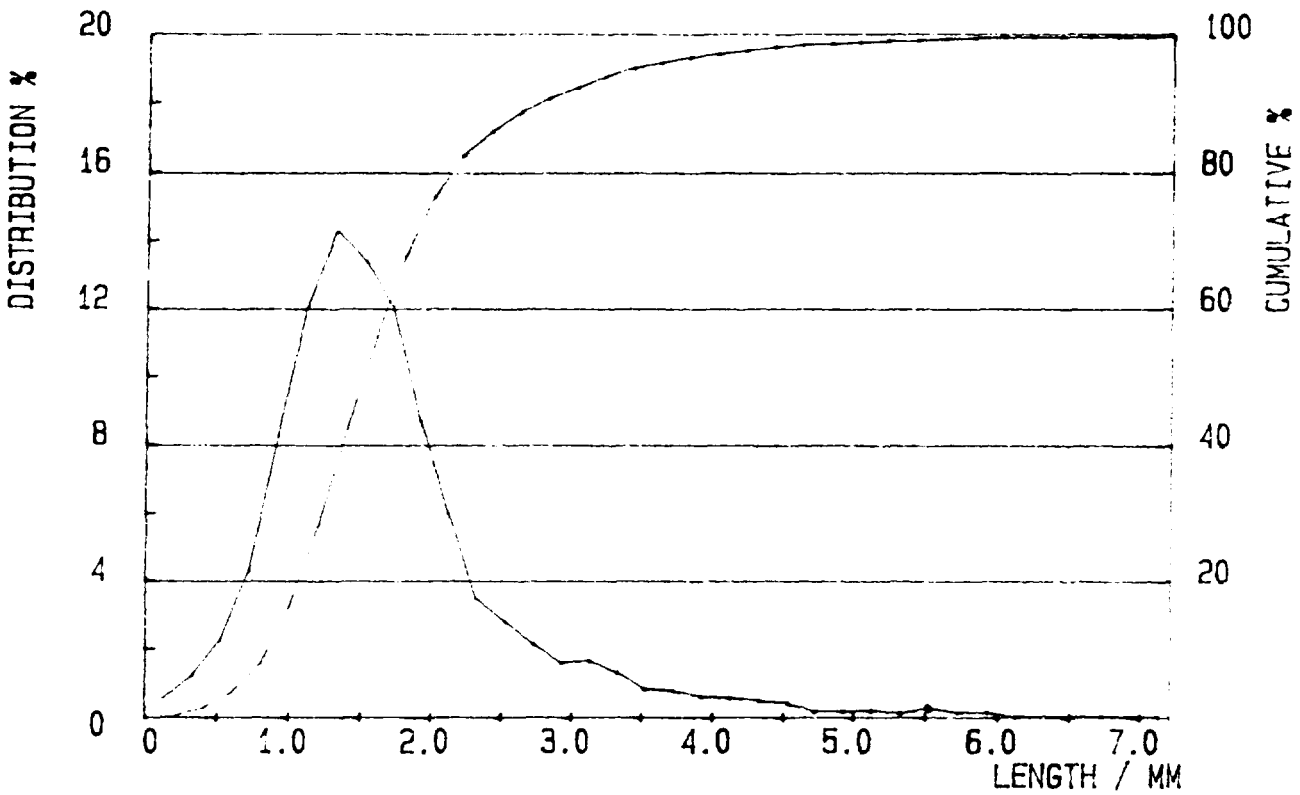
ARITHMETIC AV	1.21 mm	COARSENESS	0.120 mg/m
L WEIGHTED AV	1.63 mm	WOOD SPEC	0.0 %
W WEIGHTED AV	2.04 mm	CUSTOM /L VALUE OUT OF TABLE	

LENGTH 0.20 mm P= 7.00 % W= 0.50 %

KAJAANI FS-200 14-07-95 09: 50

WEIGHTED DISTRIBUTION

SAMPLE TITLE	N/14/95-6C-0-0-EOP-P	SAMPLE FILE NO	058
SAMPLED	14-07-95	UPPER LIMIT	6.00
ANALYSED	14-07-95 09: 47	LOWER LIMIT	0.00
TOTAL FIBERS	19486	WEIGHT	7.49 mg

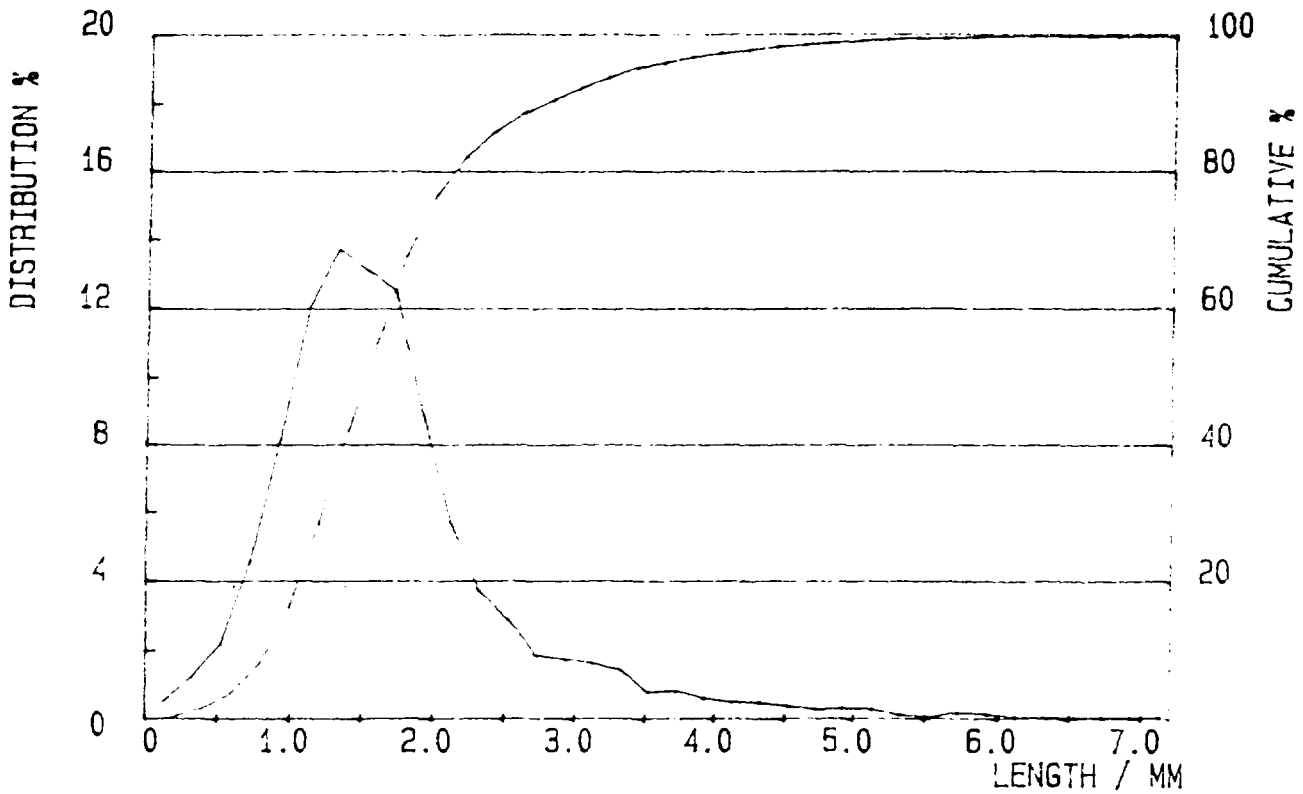


ARITHMETIC AV	1.22 mm	COARSENESS	0.113 mg/m
L WEIGHTED AV	1.65 mm	WOOD SPEC	0.0 %
W WEIGHTED AV	2.07 mm	CUSTOM /L VALUE OUT OF TABLE	
LENGTH 0.20 mm	P= 7.15 %	W= 0.50 %	

KAJAANI FS-200 14-07-95 10:01

WEIGHTED DISTRIBUTION

SAMPLE TITLE	N/14/95-6C-0-Q-EOP-P	SAMPLE FILE NO	059
SAMPLED	14-07-95	UPPER LIMIT	6.00
ANALYSED	14-07-95 10:00	LOWER LIMIT	0.00
TOTAL FIBERS	19195	WEIGHT	7.49 mg



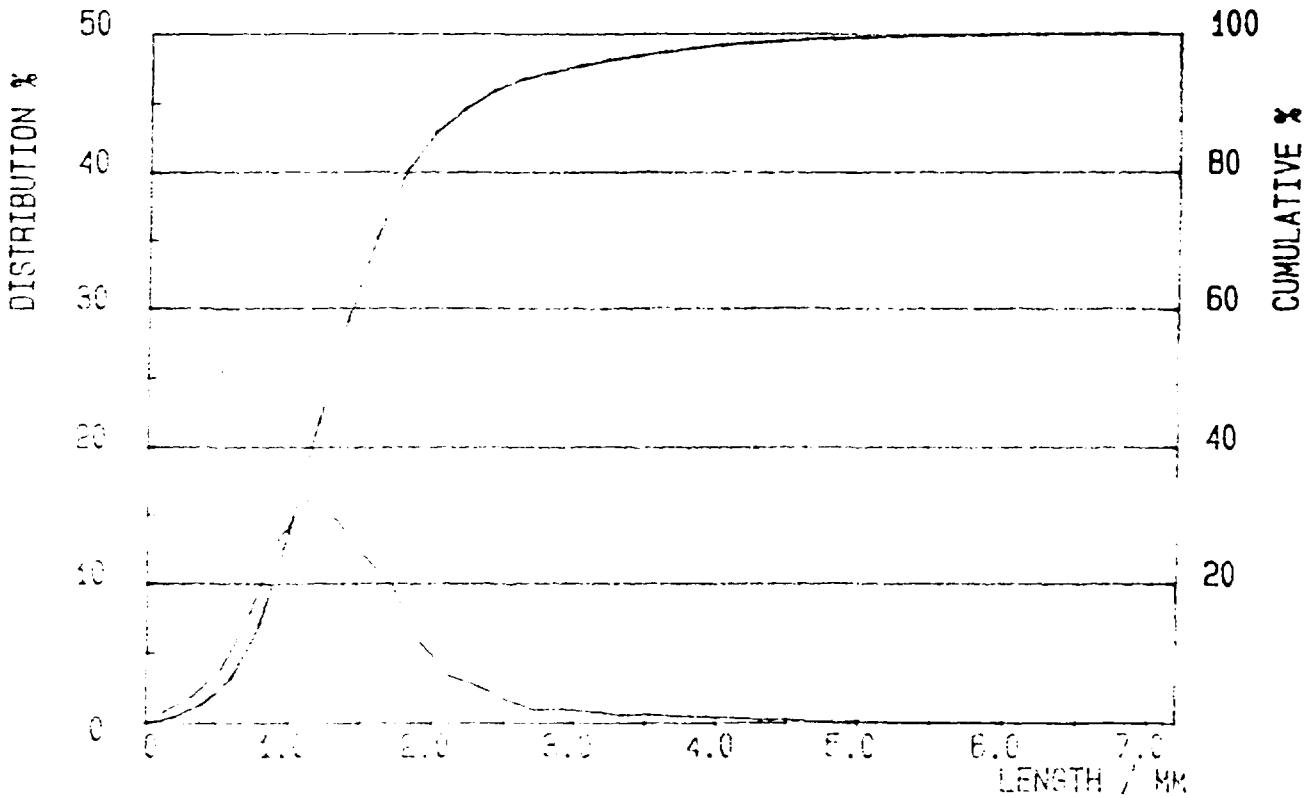
ARITHMETIC AV	1.23 mm	COARSENESS	0.116 mg/m
L WEIGHTED AV	1.66 mm	WOOD SPEC	0.0 %
W WEIGHTED AV	2.08 mm	CUSTOM /L VALUE OUT OF TABLE	

LENGTH 0.20 mm P= 6.78 % W= 0.48 %

KAJAANI FS-200 09-08-95 16: 15

WEIGHTED DISTRIBUTION

SAMPLE TITLE	IVA (OQZP) 3	SAMPLE FILE NO	016
SAMPLED	07-08-95	UPPER LIMIT	7.20
ANALYSED	09-08-95 16: 13	LOWER LIMIT	0.00
TOTAL FIBERS	23182	WEIGHT	6.28 mg



ARITHMETIC AV 1.02 mm COARSENESS 0.109 mg/m
L WEIGHTED AV 1.41 mm
W WEIGHTED AV 1.84 mm
LENGTH 0.20 mm P= 8.8[illegible] % W= 0.76 %

FINAL TEST REPORT

PHASE 1 B

ON

JUTE PULPING

FOR

UNIDO, VIENNA

BY

I V A

IMPCO-VOEST-ALPINE
Pulping Technologies GmbH

August, 1996

This final report for phase 1B replace the first and second interim report and all submitted *preliminary reports.*

TABLE OF CONTENT:

1. INTRODUCTION

This project was initiated at the request of

I T C Limited TRIBENI TISSUES DIV.

and was carried out under the contract No. 94/028, UNIDO Project DWG./IND.92/316 between

IMPCO - VOEST-ALPINE Pulping Technologies Gmbh, Linz, AUSTRIA

and

UNIDO, Vienna, AUSTRIA

In that agreement the objectives of the work were stated to be the determination of:

1. Mill scale trials to produce pulp from jute with the following process:
   Kraft AQ Pulping
   with a target Kappa of 13+- 2.

2. Testing the physical properties of the pulp produced during the mill trial.

3. Bleaching of pulp produced during the mill trial.

4. Testing the physical properties of bleached pulp

5. Recommendation for increasing jute pulp production from 9000 to 15000 tpy within the existing plant and facilities.

2. RAW MATERIAL

New raw material analysis are not available.

For information see data in Final Test Report Phase 1A.

3. RAW MATERIAL PREPARATION

The original size of the delivered jute cuts was approx. 250 mm.

The raw material had a high bark content compared to previous tests!

4. TESTING METHODS:

The following main testing methods have been used:

- Total active and effective alkali in white liquor	SCAN N 2 : 88
- Kappa number	ISO 302-1981 (E)
- Limiting viscosity number	ISO 5351/1-1981(E)
- Beating of pulp in PFI-mill	ISO 5264/2-1979
- Sheet forming (Rapid Köthen)	ISO 5269/2-1980
- Physical properties of sheets	ISO 5270-1979
- Fibre fractionation (Bauer McNett)	SCAN M6 :69
- Average fibre length and length distribution, Coarseness (Kajaani FS-200)	TAPPI T 271 PM-91
- Brightness	ISO 3688-1977 (5)
-Brightness reversion	ISO 5630/1
-Dirt in pulp	ISO 5350/2-1989 TAPPI 213
- COD (chemical oxygen demand)	DIN 38 409, Teil 41
- BOD (biochemical oxygen demand)	DIN 38 409, Teil 51
- AOX (Determination of adsorbable organic halogens)	DIN 38 409, Teil 14
- Analysis of black liquors	TAPPI T 625 CM-85
- Viscosity of black liquor	TAPPI T 666

5. PULPING EQUIPMENT:

Used at Tribeni Tissue Mill:

Digester: Spherical rotary

Diameter	m	4.3
Volume	m^3	40

Wash beater: Type Hollander

Screening and Cleaning:

only vibrating screen and cetricleaner were in operation
Other available equipment as Pressure screens were out of order.

Brown stock filter washer:

Type: Hindustan Dorr Oliver

Drum size:

Diameter	cm	243,8
Face length	cm	243.8
Wire cloth	mesh	40x36

Consistency:

Inlet	%	1,0
Outlet	%	10,0

6. MILL SCALE PULPING TESTS:

The test program was carried out at TRIBENI TISSUE Mill to produce pulp with a target Kappa about 13+-2.
Cooking condition as well as Kappa number, yield, reject amount are presented for every cooks.
After the execution of bench scale pulping tests and pilot plant trials the program for the mill trials was discussed and as follow agreed by CPPRI, Tribeni and IVA:

Cooking Process:	Kraft-AQ
Cooking Temperature:	160 °C
Heating up time	90 min
Cooking time	min 120 min
AA-Charge	min 12 % as Na_2O
Sulfidity of cooking liquor	20 %

As the existing digesters are using low pressure steam and there are no medium pressure steam lines available in the fibre line Tribeni decided to install a new line for medium pressure steam to one digester where the tests were executed.
This works were completed in December 1995.

On 4.01.1996 Tribeni started cooking jute in the digester with modified steam connection.
IVA representative Mr. Naga arrived on 22.01.1996 at Tribeni mill and conducted the tests together with Dr. Behera and his team.

The raw material had a different quality than the previous tested one. Therefore the required AA-charge was higher than tested at IVA laboratory ,CPPRI pilot plant and TTD laboratory. The quality of fiber and the high hard bark content are the reasons why this material consumed more alkali and required minimum 180 min cooking time.

During the tests we tried to optimise cooking condition not only to reach the kappa No. but also to get uniform cooked pulp with low shives content.

Cooking time reduction to 150 min or reducing the AA-charge by 0,5 % results in high shives content in pulp after breaker beater.

The final test for bleaching trials was executed on 29/30.01.1996 with the following parameter:

Raw material to digester	6850 ADkg
AA-charge	13,86 % on BDMT of raw material as Na_2O
	12,47 % on ADMT of raw material as Na_2O
Cooking time	180 min
Cooking temperature	160-163 °C
H-Factor	1600

The cooking results are:

		measured at Ljiubliana	Vienna	Tribeni
Kappa Number		11,5	11,5	12,0
Limited Viscosity	ml/g	1088	1147	
1% Cuoxam,20°C	cps			105
Brightness	% ISO		34,7	
Fiber length	mm	1,75		1,65
Coarseness	mg/m	0,173		0,128
Slenderness Factor		10,1		12,89
Mechanical properties at 50 SR:				
Breaking length	m	7393		9099
Stretch	%	3,9		3,48
MID double fold		1739		
Tensile index	Nm/g	72,52		29,27
Burst index	kPam²/g	5,06		5,84
Tear index	mNm²/g	13,27		13,23
Bendtsen porosity	ml/min	205		395
Bendtsen smoothness	ml/min	771		704
Scattering coefficient	m²/kg	17,4		
Opacity	%	98,01		

Details of cooks see table 49

Comparison of cooking results for lab. pilot and mill tests see figures 140 to 145.

Physical properties of unbleached jute pulp see table 50

Fibre analysis see distribution analysis of unbleached jute pulp

7. BENCH SCALE BLEACHING TRAILS

The following laboratory programme was carried out at IVA´ subcontractors ÖHFI in Vienna and Pulp & Paper Institute in Ljubliana, Slovenia to determinate the bleachability of the pulp produced in the Tribeni Mill under the pre scribed conditions to support the selection of the final bleaching process to be used at Tribeni mill, India.
The bleaching tests were carried out with the sequences

C - E - H

C - Ep - H

O -C - EO - H

D - E - D

O -D - EO - D

O -A - EOP - P / O -Q - EOP - P

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

A = Acidification stage

C = Chlorination stage

D = Chlorine dioxide stage

E = Extraction stage

EO = Extraction stage with addition of oxygen

EOP = Extraction stage with addition of oxygen and peroxide

EP = Extraction stage with addition of peroxide

H = Hypo stage

O = Oxygen delignification

P = Peroxide stage

Q = Chelation stage

Z = Ozone stage

7.1 C - E - H bleaching:

The target brightness for this sequence was 84 %.

The final results of brightness measurement was :

83,20 % ISO	absolute
85,20 %	relative

Details of bleaching parameter and results see table 51

7.2 C - EP - H bleaching:

The target brightness for this sequence was 86 %.

The final results of brightness measurement was :

85,2 % ISO	absolute
87,2 %	relative

Details of bleaching parameter and results see table 52

7.3 O - C - EO - H bleaching:

The target brightness for this sequence was 86 %.

The final results of brightness measurement was :

85,0 % ISO	absolute
87,0 %	relative

Details of bleaching parameter and results see table 53

7.4 D - E - D bleaching:

The target brightness for this sequence was 87,5 %.

The final results of brightness measurement was :

82,8 % ISO	absolute
84,8 %	relative

Details of bleaching parameter and results see table 54

7.5 O - D - EO - D bleaching:

The target brightness for this sequence was 88 %.

The final results of brightness measurement was :

84,9 % ISO	absolute
86,9 %	relative

Details of bleaching parameter and results see table 55

7.6 O - A - EOP - P bleaching:

The target brightness for this sequence was 84-85 %.

The final results of brightness measurement was :

81,4 % ISO	absolute
83,4 %	relative

Details of bleaching parameter and results see table 56

7.7 O - A - Z - P bleaching:

The target brightness for this sequence was 84-85 %.

The final results of brightness measurement was :

85,2 % ISO	absolute
87,2 %	relative

Details of bleaching parameter and results see table 57

7.8 Summary of bleaching trials:

Generally the bleaching results are in an acceptable ranges and confirm the previous test results.

With the simplest bleaching sequence C E H a brightness of 85,2 % could be achieved.
When adding peroxide in the extraction stage the final brightness increased to 87,2 % with a reduced total chlorine consumption.
Adding an oxygen delignification prior to the chlorination stage improves the total chlorine consumption and the brightness result.

Introducing chlorine dioxide instead of chlorine and hypo results in a brightness of 84,8 %. Adding an oxygen delignification prior to the first chlorine dioxide stage improves the total chlorine consumption and the brightness result.

Chlorine dioxide consumption of 65 kg/t of pulp (as active chlorine) in a D-E-D bleaching sequence is very high compared to 29 kg/t of pulp for chlorine and hypo consumption in a C-E-H bleaching sequence. That means that chlorine is much more efficient than chlorine dioxide for jute pulp bleaching.

In case of total chlorine free bleaching with oxygen and peroxide the final brightness was 83,4 %. Introducing ozone in an total chlorine free bleaching sequence increased the final brightness up to 87,2 %.

See table 58 and figures 151 to 177.

Fibre analysis see distribution analysis of bleached jute pulp

7.9 Cleaning test and C E H bleaching of cleaned pulp:

After execution of all bleaching trials the available sample of pulp produced during the mill trials was cleaned and bleached at the Pulp and Paper Institute in Bratislava, Slovakia.

The results show a cleaning efficiency of 66 % on brown stock. The final dirt content of C E H bleached pulp was about 9.5 mm^2/m^2.

7.9.1 Pulp cleaning test:

Type of cleaner: Radiclon P 100 - NOSS
opt. flow rate = 100 l/min

Operation data:

Stock	Consist. %	Volume flow l/min	%	Mass flow g/min	%	Pressure kPa
Inlet	0,66	100,7	100,00	664,6	100	145
Accept	0,59	88,7	88,08	523,3	78,74	20
Reject	1,17	12,0	11,92	140,4	21,13	0

Dirt content according to ISO 5350:

Group	Specks per kilogram	
	Inlet	Accept
> 5 mm^2	600	100
1,00 to 4,99 mm^2	5900	500
0,40 to 0,99 mm^2	10600	5600
0,15 to 0,39 mm^2	20400	20500

Dirt content according to TAPPI 213:

	Inlet	Accept
mm^2/m^2	2012	685
%	100	34

Cleaning Efficiency = 66 %

7.9.1 C E H bleaching of cleaned pulp:

The cleaned pulp was bleached with the sequence C E H to check the dirt reduction during the bleaching process.

Bleaching conditions:

C-Stage	Active chlorine charge	3,0 %
	Temperature	30 °C
	Retention time	45 min
	pH in	2,0
	pH out	2,0
	Consistency	3,5 %
E-Stage	Caustic charge	2,0 %
	Temperature	70 °C
	Retention time	120 min
	pH in	11,5
	pH out	9,4
	Consistency	10,0 %
H-Stage	Active chlorine charge	1,3 %
	Temperature	40 °C
	Retention time	150 min
	pH in	11,1
	pH out	10,4
	Consistency	10,0 %
Final brightness:	absolute	80,5 % ISO
	relative	82,5 % ISO
Viscosity		668 cm^3/g
Dirt content		9,5 mm^2/m^2

7.10 Comparison of different beating equipment:

To compare the results of different beating methods additional tests of the brown stock were executed at the Pulp and Paper Institute in Bratislava, Slovakia.

7.10.1 Valley beater:

Test methods: Beating, ISO 5264/1 - Valley Beater
Preparation of sheets ISO 5269/1
Conventional sheet-former
Determination of physical properties, ISO 5270

Condition of samples: Temperature 23 °C
relative humidity 50%

Results see table 59,61 and diagram 179 to 181

7.10.1 Jokro Mill:

Test methods: Beating, ISO 5264/4 - Jokro Mill
Preparation of sheets ISO 5269/2
Rapid Köchen
Determination of physical properties, ISO 5270

Condition of samples: Temperature 23 °C
relative humidity 50%

Results see table 60,61 and diagram 179 to 181

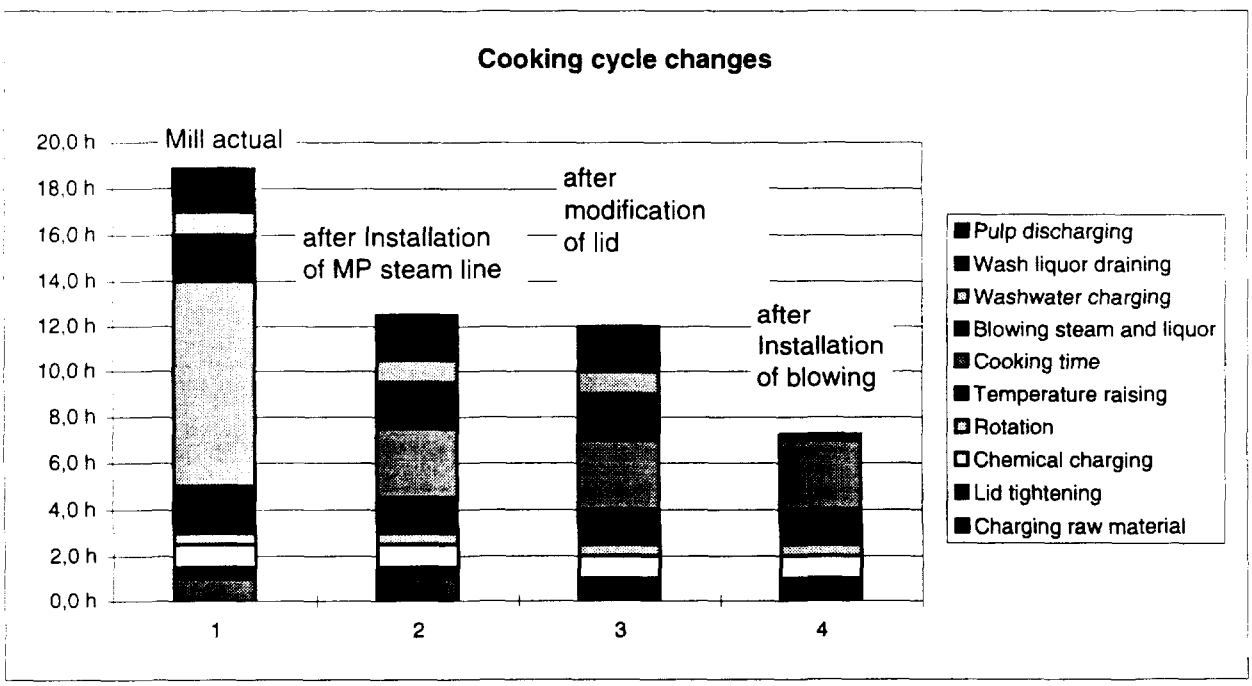
7.11 Increasing the actual plant capacity:

According to the results of cooking trials at Tribeni Mill the cooking time with the tested jute fiber at a cooking temperature about 160°C can be reduced to max. 3 h.

That means that the actual cooking cycle can be reduced from 19 hours to 12,0-12,5 hours. The capacity increase on the digester plant would be approx. 52-58 % without any additional Installation of blowing equipment. The capacity of digester would be 13680 - 14250 t/y.
In case of installing blowing equipment further time reduction of up to 5 hours are possible. In this case the total capacity increase on the digester plant would be approx. 137 % and the final capacity would be 23400 t/y.
If similar raw material quality as tested in the laboratory and pilot plant trials, is used, the total capacity of the digesting plant can be increased up to 27000 t/y.

COOKING CYCLE:

	Actual	after Installation of MP steam line	after modification of lid	after Installation of blowing equipment
Charging raw material	1,0 h	1,0 h	1,0 h	1,0 h
Lid tightening	0,5 h	0,5 h	-	-
Chemical charging	1,0 h	1,0 h	1,0 h	1,0 h
Rotation	0,5 h	0,5 h	0,5 h	0,5 h
Temperature raising	2,0 h	1,5 h	1,5 h	1,5 h
Cooking time	9,0 h	3,0 h	3,0 h	3,0 h
Blowing steam and liquor	2,0 h	2,0 h	2,0 h	0,0 h
Washwater charging	1,0 h	1,0 h	1,0 h	0,0 h
Wash liquor draining	1,5 h	1,5 h	1,5 h	0,0 h
Pulp discharging	0,5 h	0,5 h	0,5 h	0,3 h
Total time	19,0 h	12,5 h	12,0 h	7,3 h
Capacity in %	100	152	158	262
Capacity in t/y	9000	13680	14250	23586



8. TABLES

8.1 Mill scale pulping tests

TABLE 49

Jute pulping **Kraft-AQ pulping at 160°C**

Mill trial **Tribeni Tissue Devision**
City: **Tribeni**
Country: **India**
Conducted by: **Tribeni Tissue Devision, Dr. Behera**
IVA, Linz AUSTRIA , Dipl.Ing. Mohamed NAGA
Date: **January 1996**
Client: **UNIDO, Vienna for Tribeni Mill**

	Unit																				
Cook No.		5/2320	5/2327	5/2333	5/2340	5/2362	5/2395	5/2407	5/2410	5/2419	5/2420	5/2425	5/2429	5/2438	5/2440	5/2443	5/2446	5/2452	5/2458	5/2464	5/2469
Date		4.1.96	5.1.96	6.1.96	7.1.96	9.1.96	14.1.96	15.1.96	17.1.96	18.1.96	19.1.96	20.1.96	21.1.96	22.1.96	23.1.96	24.1.96	25.1.96	26.1.96	27.1.96	28.1.96	29.1.96
Raw material		Jute	Jute	Jute	Jute	Jute	Jute	Jute	Jute	Jute	Jute	Jute	Jute	Jute	Jute	Jute	Jute	Jute	Jute	Jute	Jute
Quality of Fibre		Chemex(R)	Chemex(R)	Chemex(R)	Chemex(R)	Chemex(R)	Chemex(R)	Chemex(R)						Chemex(R)	Chemex(R)	Chemex(R)	Chemex(R)	Chemex(R)	Chemex(R)	Chemex(D)	Kothari
Hard bark content	%	9,00	8,00	10,00	9,00	9,00	7,00	7,00	15,00	12,00	8,00	30,00	29,00	6,00	10,00	9,00	8,00	9,00	8,00	10,00	9,00
Size of fibre	mm	250	250	250	250	250	250	250	250	250	250	250	250	250	250	250	250	250	250	250	250
Origin of raw material		India	India	India	India	India	India	India	Bangladesh	Bangladesh	Bangladesh	Bangladesh	Bangladesh	India	India	India	India	India	India	India	India
Pulping data																					
Pulping Process		Kraft AQ	Kraft AQ	Kraft AQ	Kraft AQ	Kraft AQ	Kraft AQ	Kraft AQ	Kraft AQ	Kraft AQ	Kraft AQ	Kraft AQ	Kraft AQ	Kraft AQ	Kraft AQ	Kraft AQ	Kraft AQ	Kraft AQ	Kraft AQ	Kraft AQ	Kraft AQ
Type of digester		Spherical rotary digester	Spherical rotary digester	Spherical rotary digester	Spherical rotary digester	Spherical rotary digester	Spherical rotary digester	Spherical rotary digester	Spherical rotary digester	Spherical rotary digester	Spherical rotary digester	Spherical rotary digester	Spherical rotary digester	Spherical rotary digester	Spherical rotary digester	Spherical rotary digester	Spherical rotary digester	Spherical rotary digester	Spherical rotary digester	Spherical rotary digester	Spherical rotary digester
Size	m³	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40
Hydromodul	l/kg	2,93	2,90	2,96	2,74	2,75	2,74	2,74	2,68	2,79	2,94	2,76	2,79	2,95	3,34	3,31	3,36	3,35	3,30	3,35	3,34
Hydromodul	kg/kg	3,10	3,07	3,13	2,92	2,93	2,92	2,91	2,87	2,97	3,12	2,97	3,01	3,13	3,51	3,49	3,53	3,52	3,47	3,52	3,52
Raw material charge	kg	6405	6482	5924	6646	6620	6876	6877	7054	7143	7240	6976	6974	3961	7006	6754	6845	6676	6779	5740	7253
	kg BD	5444	5510	5036	5649	5627	5845	5846	5996	6071	6154	5930	5928	3367	5955	5741	5819	5675	5762	4879	6165
Dry content	%	85,00	85,00	85,00	85,00	85,00	85,00	85,00	85,00	85,00	85,00	85,00	85,00	85,00	85,00	85,00	85,00	85,00	85,00	85,00	85,00
NaOH Charge	%	13,89	13,88	13,88	13,90	13,90	13,97	13,90	15,56	14,97	15,00	17,78	18,89	13,92	13,89	14,07	13,89	13,88	13,89	13,34	14,45
NaOH concentration	g/lx10	70,00	71,00	72,00	71,00	70,00	71,00	71,00	71,00	71,00	71,00	71,00	71,00	71,00	71,00	71,00	71,00	71,00	71,00	71,00	71,00
NaOH liqour	l	1080	1077	971	1106	1117	1150	1144	1314	1280	1300	1485	1577	660	1165	1138	1138	1109	1127	917	1255
Na2S Charge	%	3,33	3,34	3,34	3,33	3,34	3,31	3,34	3,34	3,29	3,33	3,34	3,34	3,33	3,34	3,33	3,33	3,33	3,33	3,22	3,34
Na2S concentration	g/lx10	17,24	16,10	13,00	14,00	14,20	25,80	25,80	25,00	25,00	25,00	25,00	25,00	23,00	23,00	22,00	22,00	22,00	22,00	24,00	23,50
Na2S liqour	l	1050	1143	1292	1343	1324	750	756	800	800	820	792	792	487	865	868	882	859	873	654	877
Sulfidity	%	19,72	19,80	19,77	19,72	19,78	19,55	19,76	18,02	18,41	18,55	16,15	15,35	19,69	19,79	19,51	19,76	19,75	19,75	19,82	19,17
Active Alkali charge as Na2O	%	13,41	13,41	13,41	13,42	13,43	13,46	13,42	14,71	14,22	14,27	16,43	17,29	13,43	13,42	13,55	13,41	13,40	13,41	12,90	13,86
Effective Alkali charge as Na2O	%	12,08	12,08	12,09	12,10	12,10	12,14	12,09	13,38	12,91	12,95	15,11	15,96	12,11	12,09	12,23	12,09	12,08	12,09	11,62	12,53
AQ charge	kg	3,00	3,00	2,50	3,00	3,00	3,00	3,00	3,50	3,50	3,50	3,50	3,50	2,00	3,50	3,00	3,00	3,00	3,00	2,50	3,50
AQ charge	%	0,055	0,054	0,050	0,053	0,053	0,051	0,051	0,058	0,058	0,057	0,059	0,059	0,059	0,059	0,052	0,052	0,053	0,052	0,051	0,057
Water added	l	12870	12780	11737	12051	12059	13100	13100	12886	13770	14880	13023	13131	8203	16820	16000	16480	16032	16000	13929	17368
Total liquor to digester	l	15000	15000	14000	14500	14500	15000	15000	15000	15850	17000	15300	15500	9350	18850	18006	18500	18000	18000	15500	19500
Total liquid content	l	15961	15972	14889	15497	15493	16031	16032	16058	16921	18086	16346	16546	9944	19901	19019	19527	19001	19017	16361	20588
NaOH concentration as Na2O	g/l	47	48	47	51	50	51	51	58	54	51	65	68	47	42	42	41	41	42	40	43
Na2S concentration as Na2O	g/l	11	12	11	12	12	12	12	12	12	11	12	12	11	10	10	10	10	10	10	10
Total liquid content	kg	16898	16921	15756	16470	16463	17041	17039	17191	18030	19214	17599	17864	10525	20927	20018	20529	19978	20009	17169	21685

Heating up time to 100-110°C	min	50	45	20	30	25	30	30	50	30	30	30	30	15	45	30	45	30	45	30	45
Heating up time to 150°C	min	70	30	45	40	40	60	45	25	60	50	30	30	30	75	45	55	60	90	70	75
Time at 150°C	min											60	0	0	0	0	0	0	0	0	0
Heating up time to 160°C	min	75	45	25	35	100	15	15	25	45	10	15	30	15	45	45	35	30	45	20	45
Cooking time	min	180	180	180	180	180	180	180	180	180	180	180	180	180	180	180	180	150	150	180	180
Cooking temp.	°C	160	160-163	160-162	160-162	160	160	160-162	160-162	160-162	160	160-161	160-161-162	160-162	160-161-162	160-161-162	160-162	160-163	160-161	160-163	160-162-163
H Factor heating up		348	201	122	165	448	80	76	114	209	56	238	137	73	213	205	164	144	217	103	213
H Factor cooking		1193	1384	1303	1342	1193	1194	1268	1317	1268	1194	1264	1303	1379	1303	1264	1342	1169	1013	1426	1384
H Factor total	-	1541	1585	1425	1507	1641	1274	1344	1431	1477	1250	1502	1440	1452	1516	1469	1506	1313	1230	1529	1597
Bag Yield unscreened	%	62,40	60,10	63,00	67,00	66,20		64,50	65,30	66,30		62,50	61,00	63,10	63,40	-	-	-	62,90	69,00	62,30
Screen reject	%																				
Yield screened	%																				
Kappa No.		13,10	11,10	17,20	12,20	14,90	12,10	11,10	12,20	11,30	14,50	11,70	13,20	13,60	11,00	11,40	11,10	12,40	11,10	13,30	12,00
Initial Freeness	SR	16,5																			
	CSF	668																			
Viscosity	cps	66,0	79,2	75,0	61,2	54,0	69,0	60,0	61,5	82,5	84,0	66,0	57,0	66,0	78,0	78,0	72,0	76,8	63,0	66,0	105,0
Brightness	% ISO																				34,7
Zero beaten pulp:																					
Fibre length arithmetic average	mm																			1,25	1,23
Fibre length weighted average	mm	1,88	1,93	1,89	1,86	1,58														1,81	1,65
Fibre diameter	mm																				
Coarseness	mg/m																			0,20	0,128
Slenderness factor																				9,1	12,9
Fibre zero span tensile	km																				
Fibre zero span strength index	Nm/g	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000
Black liquor:																					
pH		11,4	11,2	11,2	11,3	11,3	11,3	11,4	11,4	11,5	11,4	11,2	11,3	11,4	11,1	10,3	10,7	11,3	11,2	11,3	11,5
Residual alkali NaOH as Na2O	g/l	5,58	5,45	3,20	4,20	3,97	4,50	4,00	4,00	3,72	3,22	7,19	6,70	4,46	3,60	3,22	2,73	3,00	5,20	1,50	4,00
Residual alkali Na2S as Na2O	g/l	0,00	0,99	0,00	0,00	0,99	2,98	2,48	2,98	2,48	2,48	1,49	1,49	2,48	1,74	2,48	3,00	2,48	2,48	1,98	1,00
Total	g/l	5,58	6,44	3,20	4,20	4,96	7,48	6,48	6,98	6,20	5,70	8,68	8,19	6,94	5,34	5,70	5,73	5,48	7,68	3,48	5,00
Viscosity at	RPM																				
	mPa.S																				
Dry solids content of org.liquor	%		13,38	13,35	14,62	14,01	13,47	13,58	14,31	14,43	13,63	15,97	14,43	15.02	12,26	12,03	12,36	11,67	10,83	11,47	11,35
Organic content of dry solids	%																				
Inorganic content of dry solids	%																				
HHV of dry solids	kcal/kg																				
	kJ/kg																				
Specific gravity	g/cm³		1,056	1,051	1,064	1,061	1,061	1,060	1,060	1,063	1,059	1,068	1,066	1,060	1,050	1,051	1,051	1,046	1,046	1,044	1,046

NOTE:

MP Steam was used to heat up the digester to cooking temperatue

LP Steam was used to heat up the digester to 150°C

TABLE 50

Physical properties of kraft-AQ Jute pulp
produced in Tribeni mill, mill trials

Laboratory: **Pulp and Paper Institute**
City: **Ljubliana**
Country: **Slovenia**
Conducted by: **IVA, Linz AUSTRIA , Dipl.Ing. Mohamed NAGA**
Date: **February 1996**
Client: **UNIDO, Vienna for Tribeni Mill**

		Sample: from test no.		Mill trials			
Physical properties:							
with PFI mill	**Unit**						
Beating point	-	0	1	2	3		
PFI revolution	rpm	1450	1450	1450	1450		
	rev.	0	2840	5600	8440	3826	7020
	min	0,00	1,96	3,86	5,82	2,64	4,84
Freeness	SR	16	25	39	61	30	50
	CSF	680	501	323	144	428	224
Drainage time	s	5,0					
Grammage	g/m²	74,36	75,55	75,55	75,87	75,55	75,71
Thickness	mm	0,163	0,128	0,115	0,108	0,123	0,111
Density	kg/m³	456	590	657	703	614	680
Bulk	m³/kg	2,193	1,695	1,522	1,422	1,633	1,472
Stretch	%	1,4	3,4	3,8	4,0	3,5	3,9
Breaking length	m	2688	6901	7198	7587	7007	7393
Burst strength	kPa	112,8	341,3	381,5	385,4	355,7	383,5
Tearing resistance	mN	953,5	1228,2	1047,7	961,4	1163,7	1004,6
MID double fold		14	2159	2122	1355	2146	1739
Tensile index	Nm/g	26,37	67,70	70,61	74,43	68,74	72,52
Burst index	kPam²/g	1,52	4,52	5,05	5,08	4,71	5,06
Tear index	mNm²/g	12,82	16,26	13,87	12,67	15,40	13,27
Bendtsen porosity	ml/min				175	3000	205
Bendtsen smoothness	ml/min			883	658	3000	771
Scattering coefficient	m²/kg	19,5	18,5	16,9	18,0	17,9	17,4
Opacity	%	98,26	98,26	97,72	98,30	98,07	98,01
Zero beaten pulp:							
Fibre length arithmetic average	mm	1,25					
Fibre length weighted average	mm	1,75					
Coarseness	mg/m	0,173					
Slenderness factor		10,1					
Fibre zero span tensile	km	10,60					
Fibre zero span strength index	Nm/g	104,0					
Dirt cont acc. TAPPI	mm²/m²	710					
Fiber fraction Bauer McNett:							
retained on mesh 14	%	83,80					
retained on mesh 30	%	5,70					
retained on mesh 50	%	2,20					
retained on mesh 100	%	0,90					
going through mesh 100	%	7,40					

TABLE 50 A

Physical properties of kraft-AQ Jute pulp
produced in Tribeni mill, mill trials

Laboratory: **Tribeni Tissue**
City: **Tribeni**
Country: **India**
Conducted by:
Date: **February 1996**
Client: **UNIDO, Vienna for Tribeni Mill**

Sample: from test no. **Mill trials**

Physical properties:							
with PFI mill	**Unit**						
Beating point	-	0	1	2	3		
PFI revolution	rpm	1450	1450	1450	1450		
	rev.	0	3500	6800	10000	3343	6495
	min	0,00	2,41	4,69	6,90	2,31	4,48
Freeness	SR	16	31	52	73	30	50
	CSF	680	415	208	72	428	224
Drainage time	s						
Grammage	g/m²	75,30	74,90	74,10	75,20	74,94	74,00
Thickness	mm	0,175	0,131	0,121	0,116	0,132	0,122
Density	kg/m³	430	570	610	650	568	606
Bulk	m³/kg	2,326	1,754	1,639	1,538	1,760	1,649
Stretch	%	1,85	4,17	3,48	4,02	4,20	3,43
Breaking length	m	4203	7566	9099	9602	7493	9051
Burst strength	kPa	136,3	395,3	433,0	472,5	393,5	429,2
Tearing resistance	mN	674,0	1080,0	980,0	843,0	1084,8	993,0
MID double fold		12	1443	1746	1922	1429	1729
Tensile index	Nm/g	41,23	74,22	89,26	94,20	73,51	88,79
Burst index	kPam²/g	1,81	5,28	5,84	6,28	5,25	5,80
Tear index	mNm²/g	8,95	14,42	13,23	11,21	14,48	13,42
Bendtsen porosity	ml/min		2207	395	88	3000	101
Bendtsen smoothness	ml/min	1402	853	704	621	3000	712
Scattering coefficient	m²/kg						
Opacity	%						
Zero beaten pulp:							
Fibre length arithmetic average	mm	1,23					
Fibre length weighted average	mm	1,65					
Coarseness	mg/m	0,128					
Slenderness factor		12,9					

8.2 Bench scale bleaching tests

TABLE 51

Bleaching of kraft-AQ Jute pulp
produced in Tribeni mill, mill trials

Laboratory: ÖHFI
City: Vienna
Country: Austria
Conducted by: IVA, Linz AUSTRIA , Dipl.Ing. Mohamed NAGA
Date: February-March 1996
Client: UNIDO, Vienna for Tribeni Mill

TABLE 51 A

	Unit		
TEST No.		A515	
Pulping process		Kraft-AQ	
Kappa No. unbleached		11,5	
Initial Brightness	% ISO	34,70	
Viscosity	ml/g	1147	
	cps		
Bleaching Sequence:		**C E H**	
First Stage		**C**	
HCl Charge	%		
Sulfamic acid	%	0,10	
Chlorination factor		0,26	
Active Chlorine applied	%	3,00	
Residual Chlorine	%	0,53	
Active Chlorine consumed	%	2,47	
Temperature	°C	30	
Retention time	min	45	
Consistency	%	3,50	
pH start		2,60	befor dosing of Cl2-water
pH end		2,00	
Second Stage		**E**	
NaOH	%	2,00	
Temperature	°C	70	
Retention time	min	120	
Consistency	%	10,00	
pH start		11,50	
pH end		11,30	
Kappa		1,10	
Viscosity	ml/g	891	
	cps		
Brightness absolute	% ISO	55,70	

Third Stage		H
Sulfamic acid	%	0,10
Active Chlorine applied	%	1,30
Residual Chlorine	%	0,91
Active Chlorine consumed	%	0,39
NaOH as Buffer	%	
Temperature	°C	40
Retention time	min	150
Consistency	%	10,00
pH start		10,90
pH end		10,00
Total Active Chlorine applied	%	4,30
Total Active Chlorine consumed	%	2,86
Final Brightness absolute	% ISO	83,20
Final Brightness relative	%	85,20
Brigtness reversion	%	4,40
Viscosity	ml/g	704

TABLE 51 B

		Sample: from test no.		A515			
Physical properties:	**Tested at Pulp and Paper Institute Ljubliana, Slovenia**						
with PFI mill	**Unit**						
Beating point	-	0	1	2	3		
PFI revolution	rpm	1450	1450	1450	1450		
	rev.	0	2820	5600	6900	3592	6900
	min	0,00	1,94	3,86	4,76	2,48	4,76
Freeness	SR	17	25	43	50	30	50
	CSF	656	501	284	224	428	224
Drainage time	s	5,5					
Grammage	g/m²	76,35	74,44	75,07	75,00	74,62	75,00
Thickness	mm	0,164	0,130	0,118	0,113	0,127	0,113
Density	kg/m³	466	573	636	664	590	664
Bulk	m³/kg	2,148	1,746	1,572	1,507	1,698	1,507
Stretch	%	1,9	2,7	3,4	3,5	2,9	3,5
Breaking length	m	2118	5252	6952	6850	5724	6850
Burst strength	kPa	109,1	285,6	319,9	355,5	295,1	355,5
Tearing resistance	mN	716	903	919	827	907	827
MID double fold		11	498	815	779	586	779
Tensile index	Nm/g	20,78	51,52	68,20	67,20	56,15	67,20
Burst index	kPam²/g	1,43	3,84	4,26	4,74	3,96	4,74
Tear index	mNm²/g	9,38	12,12	12,24	11,03	12,16	11,03
Bendtsen porosity	ml/min			910	600	3000	600
Bendtsen smoothness	ml/min			895	795	3000	795
Scattering coefficient	m²/kg	26,7	24,3	24,2	23,4	24,3	23,4
Opacity	%	82,27	81,07	82,15	81,65	81,37	81,65
Zero beaten pulp:							
Fibre length arithmetic average	mm	1,26					
Fibre length weighted average	mm	1,78					
Coarseness	mg/m	0,168					
Slenderness factor		10,6					
Fibre zero span tensile	km	9,84					
Fibre zero span strength index	Nm/g	96,5					
Dirt cont acc. TAPPI	mm²/m²	240					
Fiber fraction Bauer McNett:							
retained on mesh 14	%	75,70					
retained on mesh 30	%	10,50					
retained on mesh 50	%	3,30					
retained on mesh 100	%	1,30					
going through mesh 100	%	9,20					

TABLE 52

Bleaching of kraft-AQ Jute pulp
produced in Tribeni mill, mill trials

Laboratory: ÖHFI
City: Vienna
Country: Austria
Conducted by: IVA, Linz AUSTRIA , Dipl.Ing. Mohamed NAGA
Date: February-March 1996
Client: UNIDO, Vienna for Tribeni Mill

TABLE 52 A

	Unit		
	TEST No.	A516	
Pulping process		Kraft-AQ	
Kappa No. unbleached		11,5	
Initial Brightness	% ISO	34,70	
Viscosity	ml/g	1147	
	cps		
Bleaching Sequence:		**C Ep H**	
First Stage		**C**	
HCl Charge	%		
Sulfamic acid	%	0,10	
Chlorination factor		0,26	
Active Chlorine applied	%	3,00	
Residual Chlorine	%	0,55	
Active Chlorine consumed	%	2,45	
Temperature	°C	30	
Retention time	min	45	
Consistency	%	3,50	
pH start		2,50	befor dosing of Cl2-water
pH end		2,00	
Second Stage		**Ep**	
NaOH	%	2,00	
Peroxid applied	%	0,50	
Residual peroxid	%	0,08	
Peroxid consumed	%	0,42	
Temperature	°C	70	
Retention time	min	120	
Consistency	%	10,00	
pH start		11,40	
pH end		11,20	
Kappa		0,50	
Viscosity	ml/g	880	
	cps		
Brightness absolute	% ISO	75,10	

Third Stage		H
Sulfamic acid	%	0,10
Active Chlorine applied	%	1,30
Residual Chlorine	%	1,05
Active Chlorine consumed	%	0,25
NaOH as Buffer	%	
Temperature	°C	40
Retention time	min	150
Consistency	%	10,00
pH start		10,80
pH end		10,30
Total Active Chlorine applied	%	4,30
Total Active Chlorine consumed	%	2,70
Final Brightness absolute	% ISO	85,20
Final Brightness relative	%	87,20
Brigtness reversion	%	3,60
Viscosity	ml/g	685

TABLE 52 B

		Sample: from test no.		A516			
Physical properties:	**Tested at Pulp and Paper Institute Ljubliana, Slovenia**						
with PFI mill	**Unit**						
Beating point	-	0	1	2	3		
PFI revolution	rpm	1450	1450	1450	1450		
	rev.	0	2790	5580	6900	3446	6900
	min	0,00	1,92	3,85	4,76	2,38	4,76
Freeness	SR	17	26	43	50	30	50
	CSF	656	485	284	224	428	224
Drainage time	s	5,0					
Grammage	g/m²	74,84	74,60	74,68	74,36	74,62	74,36
Thickness	mm	0,167	0,129	0,117	0,113	0,126	0,113
Density	kg/m³	447	578	638	658	592	658
Bulk	m³/kg	2,238	1,729	1,567	1,520	1,691	1,520
Stretch	%	1,9	2,8	3,2	3,3	2,9	3,3
Breaking length	m	2389	5775	6380	6720	5917	6720
Burst strength	kPa	103,5	250,1	316,9	304,0	265,8	304,0
Tearing resistance	mN	919	1043	824	821	992	821
MID double fold		10	480	552	506	497	506
Tensile index	Nm/g	23,44	56,65	62,59	65,92	58,05	65,92
Burst index	kPam²/g	1,38	3,35	4,24	4,09	3,56	4,09
Tear index	mNm²/g	12,28	13,98	11,03	11,04	13,29	11,04
Bendtsen porosity	ml/min			955	740	3000	740
Bendtsen smoothness	ml/min			820	855	3000	855
Scattering coefficient	m²/kg	26,4	24,2	24,4	23,9	24,2	23,9
Opacity	%	80,45	79,47	80,88	81,03	79,80	81,03
Zero beaten pulp:							
Fibre length arithmetic average	mm	1,170					
Fibre length weighted average	mm	1,62					
Coarseness	mg/m	0,151					
Slenderness factor		10,7					
Fibre zero span tensile	km	9,21					
Fibre zero span strength index	Nm/g	90,4					
Dirt cont acc. TAPPI	mm²/m²	190					
Fiber fraction Bauer McNett:							
retained on mesh 14	%	77,30					
retained on mesh 30	%	14,30					
retained on mesh 50	%	3,50					
retained on mesh 100	%	1,80					
going through mesh 100	%	3,10					

TABLE 53

Bleaching of kraft-AQ Jute pulp
produced in Tribeni mill, mill trials

Laboratory: ÖHFI
City: Vienna
Country: Austria
Conducted by: IVA, Linz AUSTRIA , Dipl.Ing. Mohamed NAGA
Date: February-March 1996
Client: UNIDO, Vienna for Tribeni Mill

TABLE 53 A

	Unit	
	TEST No.	A518
Pulping process		Kraft-AQ
Kappa No. unbleached		11,5
Initial Brightness	% ISO	34,70
Viscosity	ml/g	1147
	cps	
Bleaching Sequence:		**O C EO H**
First Stage		**O**
NaOH	%	1,50
MgSO4	%	0,50
Oxygen pressure	kg/cm²	6,00
Temperature	°C	95
Retention time	min	60
Consistency	%	10,00
pH start		12,00
pH end		11,00
Kappa		8,30
Viscosity	ml/g	1063
	cps	
Brightness absolute	% ISO	49,70
Second Stage		**C**
HCl Charge	%	
Sulfamic acid	%	0,10
Chlorination factor		0,24
Active Chlorine applied	%	2,00
Residual Chlorine	%	0,50
Active Chlorine consumed	%	1,50
Temperature	°C	30
Retention time	min	45
Consistency	%	3,50
pH start		2,70
pH end		2,20

befor dosing of Cl2-water

Third Stage		**E/O**
NaOH	%	2,00
Oxygen pressure	kg/cm²	4,00
Temperature	°C	70
Retention time	min	60
Consistency	%	10,00
pH start		11,80
pH end		11,90
Kappa		0,70
Viscosity	ml/g	913
	cps	
Brightness absolute	% ISO	73,40
Forth Stage		**H**
Sulfamic acid	%	
Active Chlorine applied	%	1,30
Residual Chlorine	%	1,05
Active Chlorine consumed	%	0,25
NaOH as Buffer	%	
Temperature	°C	40
Retention time	min	150
Consistency	%	10,00
pH start		10,80
pH end		10,40
Total Active Chlorine applied	%	3,30
Total Active Chlorine consumed	%	1,75
Final Brightness absolute	% ISO	85,00
Final Brightness relative	%	87,00
Brigtness reversion	%	3,00
Viscosity	ml/g	651

TABLE 53 B

		Sample: from test no.			A518		
Physical properties:	**Tested at Pulp and Paper Institute Ljubliana, Slovenia**						
with PFI mill	**Unit**						
Beating point	-	0	1	2	3		
PFI revolution	rpm	1450	1450	1450	1450		
	rev.	0	2780	5580	7520	3527	6827
	min	0,00	1,92	3,85	5,19	2,43	4,71
Freeness	SR	17	26	41	55	30	50
	CSF	656	485	303	185	428	224
Drainage time	s	5,0					
Grammage	g/m²	74,44	74,44	73,40	73,40	74,16	73,40
Thickness	mm	0,158	0,131	0,117	0,112	0,127	0,114
Density	kg/m³	471	568	627	655	584	645
Bulk	m³/kg	2,123	1,760	1,594	1,526	1,716	1,550
Stretch	%	2,6	3,2	3,5	3,6	3,3	3,6
Breaking length	m	1973	4804	5795	7092	5068	6629
Burst strength	kPa	104,8	231,1	322,4	341,4	255,4	334,6
Tearing resistance	mN	735,7	1111,7	889,4	788,0	1052,4	824,2
MID double fold		9	380	582	900	434	786
Tensile index	Nm/g	19,36	47,13	56,85	69,57	49,72	65,03
Burst index	kPam²/g	1,41	3,10	4,39	4,65	3,44	4,56
Tear index	mNm²/g	9,88	14,93	12,12	10,74	14,19	11,23
Bendtsen porosity	ml/min				615	3000	653
Bendtsen smoothness	ml/min			875	745	3000	791
Scattering coefficient	m²/kg	25,6	24,6	24,1	23,9	24,4	24,0
Opacity	%	79,45	79,71	80,07	80,57	79,81	80,39
Zero beaten pulp:							
Fibre length arithmetic average	*mm*	1,05					
Fibre length weighted average	mm	1,43					
Coarseness	mg/m	0,121					
Slenderness factor		11,8					
Fibre zero span tensile	km	9,15					
Fibre zero span strength index	Nm/g	89,8					
Dirt cont acc. TAPPI	mm²/m²	170,00					
Fiber fraction Bauer McNett:							
retained on mesh 14	%	64,90					
retained on mesh 30	%	23,80					
retained on mesh 50	%	3,80					
retained on mesh 100	%	1,40					
going through mesh 100	%	6,10					

TABLE 54

Bleaching of kraft-AQ Jute pulp
produced in Tribeni mill, mill trials

Laboratory: ÖHFI
City: Vienna
Country: Austria
Conducted by: IVA, Linz AUSTRIA , Dipl.Ing. Mohamed NAGA
Date: February-March 1996
Client: ***UNIDO, Vienna for Tribeni Mill***

TABLE 54 A

	Unit			
	TEST No.	A517	A523	A524
Pulping process		Kraft-AQ	Kraft-AQ	Kraft-AQ
Kappa No. unbleached		11,5	11,5	11,5
Initial Brightness	% ISO	34,70	34,70	34,70
Viscosity	ml/g	1147	1147	1147
	cps			
Bleaching Sequence:		**D E D**	**D E D**	**D E D**
First Stage		**D0**	**D1**	**D1**
HCl Charge	%			
Sulfamic acid	%	0,00	0,00	0,00
Chlorination factor		0,26	0,35	0,35
Active Chlorine applied	%	3,00	4,00	4,00
Residual Chlorine	%	0,00	0,00	0,01
Active Chlorine consumed	%	3,00	4,00	3,99
Temperature	°C	60	60	55
Retention time	min	60	60	60
Consistency	%	10,00	10,00	10,00
pH start		2,90	3,40	2,60
pH end		3,20	2,80	2,40
Second Stage		**E**	**E**	**E**
NaOH	%	2,00	2,00	2,00
Temperature	°C	70	70	70
Retention time	min	120	120	120
Consistency	%	10,00	10,00	10,00
pH start		11,50	11,70	11,60
pH end		11,10	11,70	11,60
Kappa		5,02	5,02	2,50
Viscosity	ml/g	1050	1061	1075
	cps			
Brightness absolute	% ISO	58,20	64,10	64,40

Third Stage		D1	D2	D2	
Sulfamic acid	%	0,00	0,00	0,00	
Active Chlorine applied	%	2,50	2,50	2,50	
Residual Chlorine	%	0,00	0,06	0,00	
Active Chlorine consumed	%	2,50	2,44	2,50	
NaOH as Buffer	%				
Temperature	°C	70	70	70	
Retention time	min	180	180	180	
Consistency	%	10,00	10,00	10,00	
pH start		3,20	3,10	5,20	
pH end		3,80	2,50	3,60	
Total Active Chlorine applied	%	5,50	6,50	6,50	
Total Active Chlorine consumed	%	5,50	6,44	6,49	
Final Brightness absolute	% ISO	76,50	81,20	82,80	
Final Brightness relative	%	78,50	83,20	84,80	
Brigtness reversion	%		3,90	2,60	
Viscosity	ml/g	1039	1019	1051	1031

TABLE 54 B

		Sample: from test no.		A524			
Physical properties:	**Tested at Pulp and Paper Institute Ljubliana, Slovenia**						
with PFI mill	**Unit**						
Beating point	-	0	1	2	3		
PFI revolution	rpm	1450	1450	1450	1450		
	rev.	0	2800	5500	9580	4900	9580
	min	0,00	1,93	3,79	6,61	3,38	6,61
Freeness	SR	16	23	32	50	30	50
	CSF	680	535	402	224	428	224
Drainage time	s	4,5					
Grammage	g/m²	75,95	75,00	74,28	75,56	74,44	75,56
Thickness	mm	0,165	0,134	0,122	0,114	0,125	0,114
Density	kg/m³	460	560	609	663	598	663
Bulk	m³/kg	2,172	1,787	1,642	1,509	1,674	1,509
Stretch	%	1,8	3,0	3,1	3,8	3,1	3,8
Breaking length	m	2488	6016	6743	7854	6581	7854
Burst strength	kPa	98,1	255,0	322,7	347,2	307,6	347,2
Tearing resistance	mN	1020,0	1287,0	1099,0	989,0	1141	989
MID double fold		9	1095	1413	1293	1342	1293
Tensile index	Nm/g	24,41	59,02	66,15	77,05	64,56	77,05
Burst index	kPam²/g	1,29	3,40	4,34	4,59	4,13	4,59
Tear index	mNm²/g	13,43	17,16	14,80	13,09	15,32	13,09
Bendtsen porosity	ml/min				540	3000	540
Bendtsen smoothness	ml/min		970	895	875	912	875
Scattering coefficient	m²/kg	26,5	23,4	23,1	24,2	23,2	24,2
Opacity	%	81,87	80,37	81,21	83,23	81,02	83,23
Zero beaten pulp:							
Fibre length arithmetic average	mm	1,16					
Fibre length weighted average	mm	1,54					
Coarseness	mg/m	0,110					
Slenderness factor		14,0					
Fibre zero span tensile	km	9,28					
Fibre zero span strength index	Nm/g	91,0					
Dirt cont acc. TAPPI	mm²/m²	210					
Fiber fraction Bauer McNett:							
retained on mesh 14	%	79,00					
retained on mesh 30	%	11,80					
retained on mesh 50	%	3,10					
retained on mesh 100	%	1,40					
going through mesh 100	%	4,70					

TABLE 55

Bleaching of kraft-AQ Jute pulp
produced in Tribeni mill, mill trials

Laboratory: **ÖHFI**
City: **Vienna**
Country: **Austria**
Conducted by: **IVA, Linz AUSTRIA , Dipl.Ing. Mohamed NAGA**
Date: **February-March 1996**
Client: **UNIDO, Vienna for Tribeni Mill**

TABLE 55 A

	Unit	
	TEST No.	A519
Pulping process		Kraft-AQ
Kappa No. unbleached		11,5
Initial Brightness	% ISO	34,70
Viscosity	ml/g	1147
	cps	
Bleaching Sequence:		**O D EO D**
First Stage		**O**
NaOH	%	1,50
MgSO4	%	0,50
Oxygen pressure	kg/cm²	6,00
Temperature	°C	95
Retention time	min	60
Consistency	%	10,00
pH start		12,00
pH end		11,00
Kappa		8,30
Viscosity	ml/g	1063,00
	cps	
Brightness absolute	% ISO	49,70
Second Stage		**D0**
HCl Charge	%	
Sulfamic acid	%	0,00
Chlorination factor		0,24
Active Chlorine applied	%	2,00
Residual Chlorine	%	0,27
Active Chlorine consumed	%	1,73
Temperature	°C	60
Retention time	min	60
Consistency	%	10,00
pH start		5,50
pH end		5,50

Third Stage		**E/O**
NaOH	%	2,00
Oxygen pressure	kg/cm²	4,00
Temperature	°C	70
Retention time	min	60
Consistency	%	10,00
pH start		11,90
pH end		11,90
Kappa		3,50
Viscosity	ml/g	917,00
	cps	
Brightness absolute	% ISO	75,30
Forth Stage		**D1**
Sulfamic acid	%	
Active Chlorine applied	%	2,50
Residual Chlorine	%	0,00
Active Chlorine consumed	%	2,50
NaOH as Buffer	%	
Temperature	°C	70
Retention time	min	180
Consistency	%	10,00
pH start		3,40
pH end		3,20
Total Active Chlorine applied	%	4,50
Total Active Chlorine consumed	%	4,23
Final Brightness absolute	% ISO	84,90
Final Brightness relative	%	86,90
Brigtness reversion	%	3,80
Viscosity	ml/g	887

TABLE 55 B

		Sample: from test no.			A519		
Physical properties:	**Tested at Pulp and Paper Institute Ljubljana, Slovenia**						
with PFI mill	**Unit**						
Beating point	-	0	1	2	3		
PFI revolution	rpm	1450	1450	1450	1450		
	rev.	0	2800	5500	8100	4150	8100
	min	0,00	1,93	3,79	5,59	2,86	5,59
Freeness	SR	17	25	35	50	30	50
	CSF	656	501	366	224	428	224
Drainage time	s	5,0					
Grammage	g/m²	73,81	73,88	73,96	73,72	73,92	73,72
Thickness	mm	0,155	0,132	0,121	0,114	0,127	0,114
Density	kg/m³	476	560	611	647	585	647
Bulk	m³/kg	2,100	1,787	1,636	1,546	1,711	1,546
Stretch	%	2,9	2,8	3,3	3,5	3,1	3,5
Breaking length	m	2513	5271	6140	6975	5706	6975
Burst strength	kPa	88,3	223,7	285,0	296,7	254,4	296,7
Tearing resistance	mN	785	1432	1043	939	1238	939
MD double fold		7	541	999	963	770	963
Tensile index	Nm/g	24,65	51,71	60,23	68,42	55,97	68,42
Burst index	kPam²/g	1,20	3,03	3,85	4,02	3,44	4,02
Tear index	mNm²/g	10,63	19,39	14,10	12,73	16,74	12,73
Bendtsen porosity	ml/min				860	3000	860
Bendtsen smoothness	ml/min		940	825	815	883	815
Scattering coefficient	m²/kg	25,3	23,4	23,2	23,7	23,3	23,7
Opacity	%	80,18	79,67	79,98	80,82	79,83	80,82
Zero beaten pulp:							
Fibre length arithmetic average	mm	1,06					
Fibre length weighted average	mm	1,45					
Coarseness	mg/m	0,158					
Slenderness factor		9,2					
Fibre zero span tensile	km	8,86					
Fibre zero span strength index	Nm/g	86,9					
Dirt cont acc. TAPPI	mm²/m²	230,00					
Fiber fraction Bauer McNett:							
retained on mesh 14	%	56,00					
retained on mesh 30	%	25,80					
retained on mesh 50	%	4,20					
retained on mesh 100	%	1,80					
going through mesh 100	%	12,20					

TABLE 56

Bleaching of kraft-AQ Jute pulp
produced in Tribeni mill, mill trials

Laboratory: ÖHFI
City: Vienna
Country: Austria
Conducted by: IVA, Linz AUSTRIA , Dipl.Ing. Mohamed NAGA
Date: February-March 1996
Client: UNIDO, Vienna for Tribeni Mill

TABLE 56 A

	Unit	
	TEST No.	A520
Pulping process		Kraft-AQ
Kappa No. unbleached		11,5
Initial Brightness	% ISO	34,70
Viscosity	ml/g	1147
	cps	
Bleaching Sequence:		**O A EOP P**
First Stage		**O**
NaOH	%	1,50
MgSO4	%	0,50
Oxygen pressure	kg/cm²	6,00
Temperature	°C	95
Retention time	min	60
Consistency	%	10,00
pH start		12,00
pH end		11,00
Kappa		8,30
Viscosity	ml/g	1063
	cps	
Brightness absolute	% ISO	49,70
Second Stage		**A**
HCl Charge	%	
DTPA	%	0,00
H2SO4	%	
Temperature	°C	70
Retention time	min	30
Consistency	%	10,00
pH start		2,30
pH end		2,50
Viscosity	ml/g	1065
Brightness absolute	% ISO	50,20

Third Stage		**EOP**
NaOH	%	1,50
Peroxid applied	%	3,00
Residual peroxid	%	0,05
Peroxid consumed	%	2,95
DTPA	%	0,20
EDTA	%	
MgSO4	%	0,20
H2SO4	%	
Oxygen pressure	kg/cm²	4,00
Temperature	°C	85
Retention time	min	15/150
Consistency	%	10,00
pH start		10,70
pH end		10,70
Kappa		5,20
Viscosity	ml/g	678
Brightness absolute	% ISO	77,30
Forth Stage		**P**
NaOH	%	0,75
Peroxid applied	%	1,50
Residual peroxid	%	1,33
Peroxid consumed	%	0,17
DTPA	%	0,20
EDTA	%	
MgSO4	%	0,20
Temperature	°C	90
Retention time	min	180
Consistency	%	10,00
pH start		10,00
pH end		10,50
Final Brightness absolute	% ISO	81,40
Final Brightness relative	%	83,40
Brigtness reversion	%	3,80
Viscosity	ml/g	679

TABLE 56 B

		Sample: from test no.			A520		
Physical properties:	**Tested at Pulp and Paper Institute Ljubliana, Slovenia**						
with PFI mill	**Unit**						
Beating point	-	0	1	2	3		
PFI revolution	rpm	1450	1450	1450	1450		
	rev.	0	2800	4180	5590	3107	5590
	min	0,00	1,93	2,88	3,86	2,14	3,86
Freeness	SR	18	28	37	50	30	50
	CSF	633	456	344	224	428	224
Drainage time	s	5,0					
Grammage	g/m²	73,96	74,12	74,20	72,93	74,14	72,93
Thickness	mm	0,155	0,128	0,121	0,113	0,126	0,113
Density	kg/m³	477	579	613	645	587	645
Bulk	m³/kg	2,096	1,727	1,631	1,549	1,705	1,549
Stretch	%	2,6	3,2	3,4	3,3	3,2	3,3
Breaking length	m	2380	5725	6063	6867	5800	6867
Burst strength	kPa	108,9	254,9	285,6	310,8	261,7	310,8
Tearing resistance	mN	788	1073	893	821	1033	821
MID double fold		9	449	537	621	469	621
Tensile index	Nm/g	23,35	56,16	59,48	67,37	56,90	67,37
Burst index	kPam²/g	1,47	3,44	3,85	4,26	3,53	4,26
Tear index	mNm²/g	10,66	14,47	12,03	11,25	13,93	11,25
Bendtsen porosity	ml/min				920,0	3000,0	920,0
Bendtsen smoothness	ml/min		945,0	835,0	785,0	920,6	785,0
Scattering coefficient	m²/kg	23,6	23,8	22,9	22,4	23,6	22,4
Opacity	%	79,02	80,53	79,78	79,69	80,36	79,69
Zero beaten pulp:							
Fibre length arithmetic average	mm	1,07					
Fibre length weighted average	mm	1,43					
Coarseness	mg/m	0,117					
Slenderness factor		12,2					
Fibre zero span tensile	km	8,68					
Fibre zero span strength index	Nm/g	85,2					
Dirt cont acc. TAPPI	mm²/m²	290					
Fiber fraction Bauer McNett:							
retained on mesh 14	%	50,90					
retained on mesh 30	%	34,30					
retained on mesh 50	%	4,30					
retained on mesh 100	%	2,00					
going through mesh 100	%	8,50					

TABLE 57

Bleaching of kraft-AQ Jute pulp
produced in Tribeni mill, mill trials

Laboratory: ÖHFI
City: Vienna
Country: Austria
Conducted by: IVA, Linz AUSTRIA , Dipl.Ing. Mohamed NAGA
Date: February-March 1996
Client: UNIDO, Vienna for Tribeni Mill

TABLE 57 A

	Unit	
	TEST No.	A521
Pulping process		Kraft-AQ
Kappa No. unbleached		11,5
Initial Brightness	% ISO	34,70
Viscosity	ml/g	1147
Bleaching Sequence:		**O A Z P**
First Stage		**O**
NaOH	%	1,50
MgSO4	%	0,50
Oxygen pressure	kg/cm²	6,00
Temperature	°C	95
Retention time	min	60
Consistency	%	10,00
pH start		12,00
pH end		11,00
Kappa		8,30
Viscosity	ml/g	1063
Brightness absolute	% ISO	49,70
Second Stage		**A**
HCl Charge	%	
NaOH	%	
EDTA	%	
MgSO4	%	
H2SO4	%	
Temperature	°C	70
Retention time	min	30
Consistency	%	10,00
pH start		2,30
pH end		2,30
Kappa		
Viscosity	ml/g	1066
Brightness absolute	% ISO	50,20

Third Stage		**Z**
HCl Charge	%	
NaOH	%	
O3 applied	%	0,72
O3 Residual	%	0,27
O3 consumed	%	0,45
DTPA	%	
MgSO4	%	
H2SO4	%	
Temperature	°C	50
Retention time	min	5
Consistency	%	10,00
pH start		1,90
pH end		1,90
Kappa		
Viscosity	ml/g	774,00
Brightness absolute	% ISO	67,50
Forth Stage		**P**
NaOH	%	1,50
Peroxid applied	%	3,00
Residual peroxid	%	2,43
Peroxid consumed	%	0,57
DTPA	%	0,20
MgSO4	%	0,20
H2SO4	%	
Temperature	°C	90
Retention time	min	180
Consistency	%	10,00
pH start		10,40
pH end		10,40
Final Brightness absolute	% ISO	85,20
Final Brightness relative	%	87,20
Brigtness reversion	%	1,30
Viscosity	ml/g	529

TABLE 57 B

		Sample: from test no.		A521			
Physical properties:	**Tested at Pulp and Paper Institute Ljubliana, Slovenia**						
with PFI mill	**Unit**						
Beating point	-	0	1	2	3		
PFI revolution	rpm	1450	1450	1450	1450		
	rev.	0	2800	4110	5450	2931	5450
	min	0,00	1,93	2,83	3,76	2,02	3,76
Freeness	SR	17	29	39	50	30	50
	CSF	656	442	323	224	428	224
Drainage time	s	5,0					
Grammage	g/m²	73,80	74,12	74,68	74,84	74,18	74,84
Thickness	mm	0,156	0,129	0,122	0,117	0,128	0,117
Density	kg/m³	473	575	612	640	578	640
Bulk	m³/kg	2,114	1,740	1,634	1,563	1,730	1,563
Stretch	%	2,3	2,9	3,3	3,0	2,9	3,0
Breaking length	m	2163	5018	5461	5551	5062	5551
Burst strength	kPa	93,2	201,0	259,9	269,7	206,9	269,7
Tearing resistance	mN	965	899	948	811	904	811
MID double fold		10	149	132	137	147	137
Tensile index	Nm/g	21,22	49,23	53,57	54,46	49,66	54,46
Burst index	kPam²/g	1,26	2,71	3,48	3,60	2,79	3,60
Tear index	mNm²/g	13,08	12,13	12,70	10,84	12,19	10,84
Bendtsen porosity	ml/min				930	3000	930
Bendtsen smoothness	ml/min		890	910	940	892	940
Scattering coefficient	m²/kg	24,8	24,7	25,1	25,1	24,7	25,1
Opacity	%	79,02	80,04	80,42	81,17	80,08	81,17
Zero beaten pulp:							
Fibre length arithmetic average	mm	1,04					
Fibre length weighted average	mm	1,38					
Coarseness	mg/m	0,124					
Slenderness factor		11,1					
Fibre zero span tensile	km	7,76					
Fibre zero span strength index	Nm/g	76,1					
Dirt cont acc. TAPPI	mm²/m²	190					
Fiber fraction Bauer McNett:							
retained on mesh 14	%	60,90					
retained on mesh 30	%	28,90					
retained on mesh 50	%	4,10					
retained on mesh 100	%	1,50					
going through mesh 100	%	4,60					

TABLE 58

Summery of Bleaching tests for kraft-AQ Jute pulp produced in Tribeni mill, mill trials

SEQUENCE	Lab	TEST No.	Bright-ness absolute	Bright-ness relative	Limited Viscosity	Breakg. length at 50 SR	Fibre length weight. average	Coarse-ness	Slender-ness factor
			% ISO	%	ml/g	m	mm	mg/m	
Brown stock			34,70	36,70	1147	7393	1,75	0,173	10,12
C-E-H	ÖHFI/ICP	A515	83,20	85,20	704	6850	1,78	0,168	10,60
C-EP-H	ÖHFI/ICP	A516	85,20	87,20	685	6720	1,62	0,151	10,73
O-C-EO-H	ÖHFI/ICP	A518	85,00	87,00	651	6629	1,43	0,121	11,82
D-E-D	ÖHFI	A517	76,50	78,50	1039	-	-	-	-
	ÖHFI	A523	81,20	83,20	1019	-	-	-	-
	ÖHFI/ICP	A524	82,80	84,80	1051	7854	1,54	0,11	14
O-D-EO-D	ÖHFI/ICP	A519	84,90	86,90	887	6975	1,45	0,158	9,18
O-A-EOP-P	ÖHFI/ICP	A520	81,40	83,40	679	6867	1,43	0,117	12,22
O-A-Z-P	ÖHFI/ICP	A521	85,20	87,20	529	5551	1,38	0,124	11,13

8.3 Comparison of different beating equipment

TABLE 59

Physical properties of kraft-AQ Jute pulp
produced in Tribeni mill, mill trials

Laboratory: **Pulp and Paper Institute**
City: **Bratslava**
Country: **Slovakia**
Conducted by: **IVA, Linz AUSTRIA , Dipl.Ing. Mohamed NAGA**
Date: **June/July 1996**
Client: ***UNIDO, Vienna for Tribeni Mill***

		Sample: from test no.			Mill trials			
Physical properties:								
with Valley Beater	**Unit**							
Beating point	-	0	1	2	3	4		
	min	0,00	20,00	30,00	40,00	50,00	24,44	44,17
Freeness	SR	16	26	35	45	57	30	50
	CSF	680	485	366	266	171	428	224
Density	kg/m³	340	540	570	580	610	553	593
Bulk	m³/kg	2,941	1,852	1,754	1,724	1,639	1,809	1,689
Stretch	%	1,4	3,0	3,1	3,2	3,2	3,0	3,2
Tensile index	Nm/g	23,00	75,50	82,50	86,00	87,50	78,61	86,63
Burst index	kPam²/g	1,30	5,55	6,55	6,50	6,45	5,99	6,48
Tear index	mNm²/g	10,60	13,70	12,80	11,10	10,20	13,30	10,73
Gurley	s	0,3	2,3	8,3	29,0	95,0	5,0	56,50

TABLE 60

Physical properties of kraft-AQ Jute pulp
produced in Tribeni mill, mill trials

Laboratory: **Pulp and Paper Institute**
City: **Bratslava**
Country: **Slovakia**
Conducted by: **IVA, Linz AUSTRIA , Dipl.Ing. Mohamed NAGA**
Date: **June/July 1996**
Client: **UNIDO, Vienna for Tribeni Mill**

		Sample: from test no.			Mill trials			
Physical properties:	**at 30 SR**							
with Jokro Mill	**Unit**							
Beating point	-	0	1	2	3	4		
	min	0,00	28,00	45,00	65,00	80,00	38,20	71,25
Freeness	SR	16	24	34	45	57	30	50
	CSF	680	517	378	266	171	428	224
Density	kg/m³	450	600	650	680	720	630	697
Bulk	m³/kg	2,222	1,667	1,538	1,471	1,389	1,590	1,437
Stretch	%	0,8	1,7	2,2	2,6	2,8	2,0	2,7
Tensile index	Nm/g	17,50	44,50	55,00	66,00	74,50	50,80	69,54
Burst index	kPam²/g	0,95	2,80	3,85	4,20	4,45	3,43	4,30
Tear index	mNm²/g	12,00	15,50	14,00	12,50	11,50	14,60	12,08
Gurley	s	0,4	1,4	5,5	16,0	48,0	3,86	29,33

TABLE 61

Physical properties of kraft-AQ Jute pulp

produced in Tribeni mill, mill trials

Sample: from test no. **Mill trials**

Physical properties: **at 30 SR**

	Unit	PFI	Valley	Jokro
Density	kg/m³	613,93	553,33	630,00
Bulk	m³/kg	1,63	1,81	1,59
Stretch	%	3,54	3,04	2,00
Tensile index	Nm/g	68,74	78,61	50,80
	%	100,00	114,36	73,90
Burst index	kPam²/g	4,71	5,99	3,43
	%	100,00	127,34	72,86
Tear index	mNm²/g	15,40	13,30	14,60
	%	100,00	86,34	94,78

Physical properties: **at 50 SR**

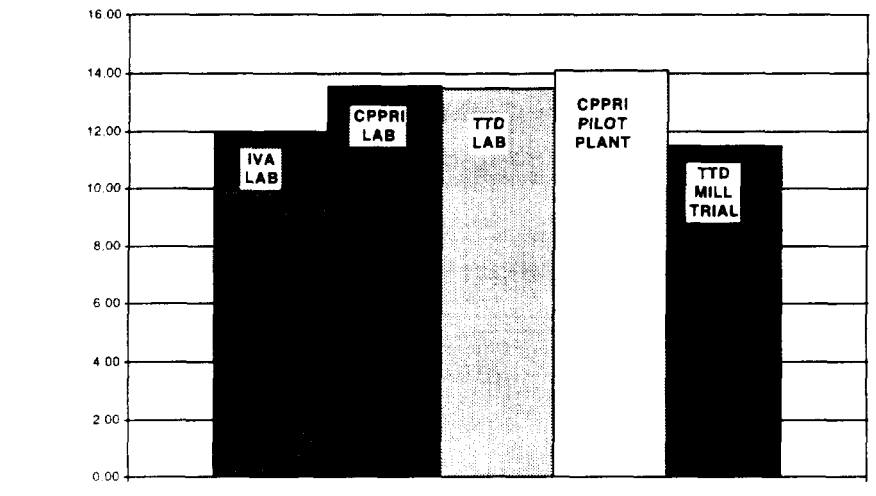
	Unit	PFI	Valley	Jokro
Density	kg/m³	680,00	592,50	696,67
Bulk	m³/kg	1,47	1,69	1,44
Stretch	%	3,90	3,20	2,68
Tensile index	Nm/g	72,52	86,63	69,54
	%	100,00	119,45	95,89
Burst index	kPam²/g	5,06	6,48	4,30
	%	100,00	127,93	84,98
Tear index	mNm²/g	13,27	10,73	12,08
	%	100,00	80,83	91,07

9. DIAGRAMS

9.1 Mill pulping tests

at TRIBENI TISSUE

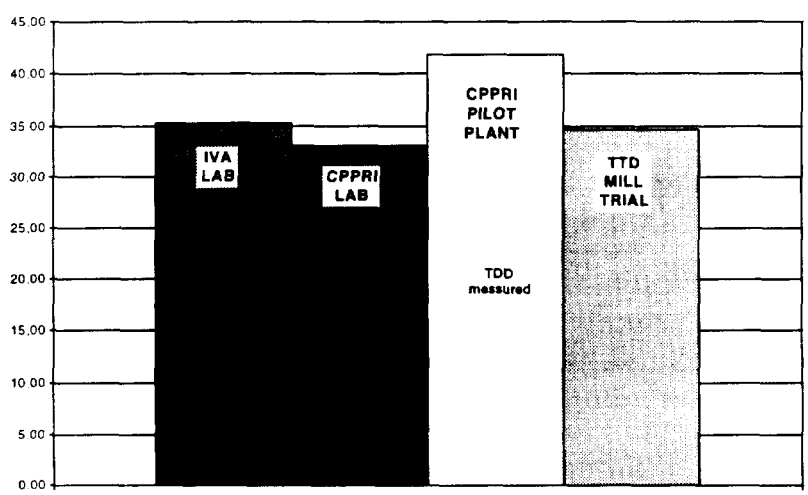
KAPPA NR. OF UNBLEACHED KRAFT-AQ JUTE PULP



ppt\Projekte\Tribeni\Report 1\b Figure 140

JUTE PULPING

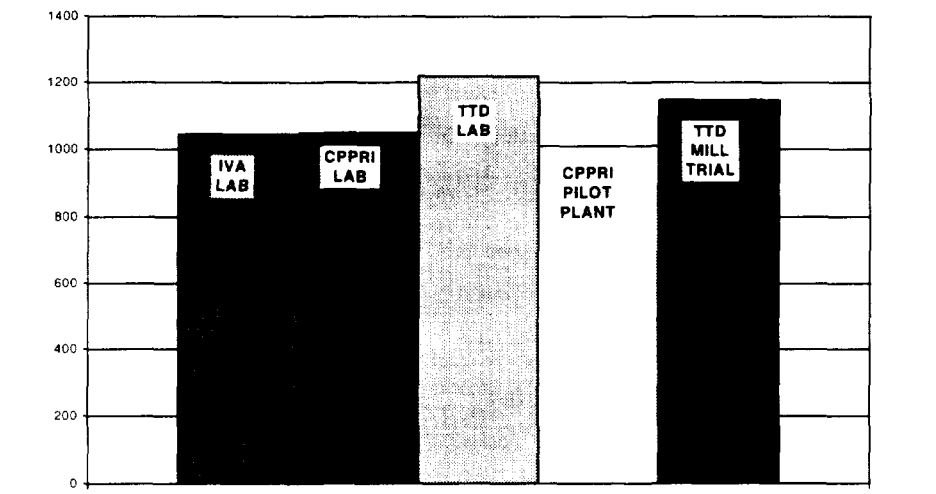
BRIGHTNESS [%]OF UNBLEACHED KRAFT-AQ JUTE PULP



ppt\Projekte\Tribeni\Report 1\b Figure 141

JUTE PULPING

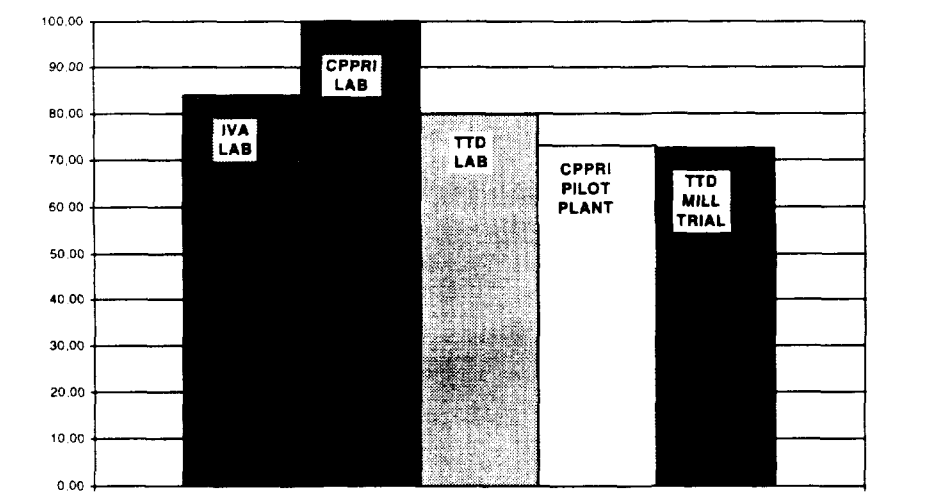
VISCOSITY[ml/g]OF UNBLEACHED KRAFT-AQ JUTE PULP



ppt\Projekte\Tribeni\Report 1\b Figure 142

JUTE PULPING

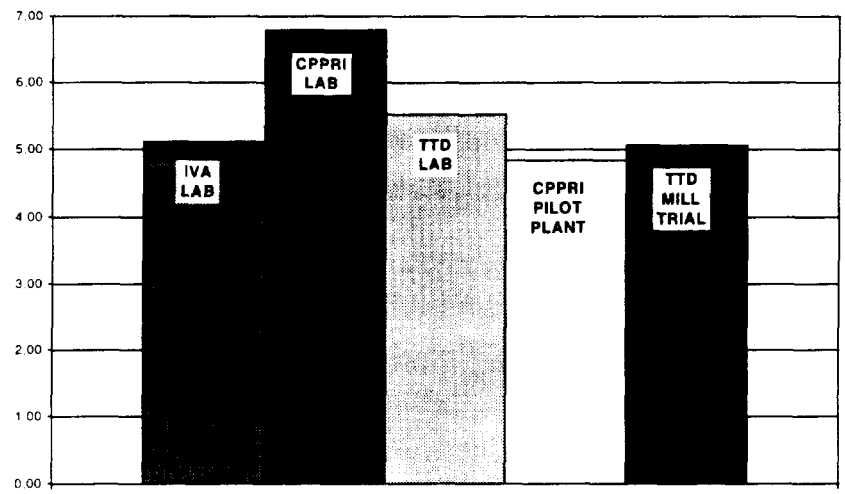
TENSILE INDEX [Nm/g] OF UNBLEACHED KRAFT-AQ JUTE PULP AT 50 SR



ppt\Projekte\Tribeni\Report 1\b Figure 143

JUTE PULPING

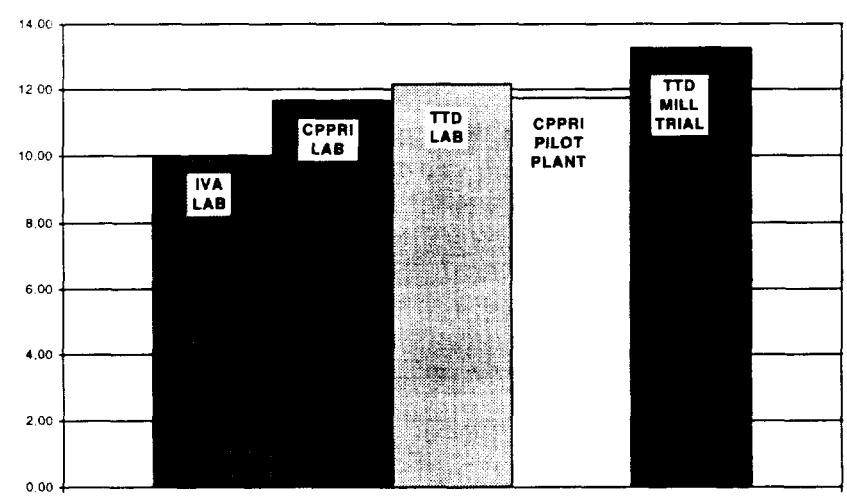
BURST INDEX [kPam2/g]OF UNBLEACHED KRAFT-AQ JUTE PULP AT 50 SR



ppt\Projekte\Tribeni\Report 1\b Figure 144

JUTE PULPING

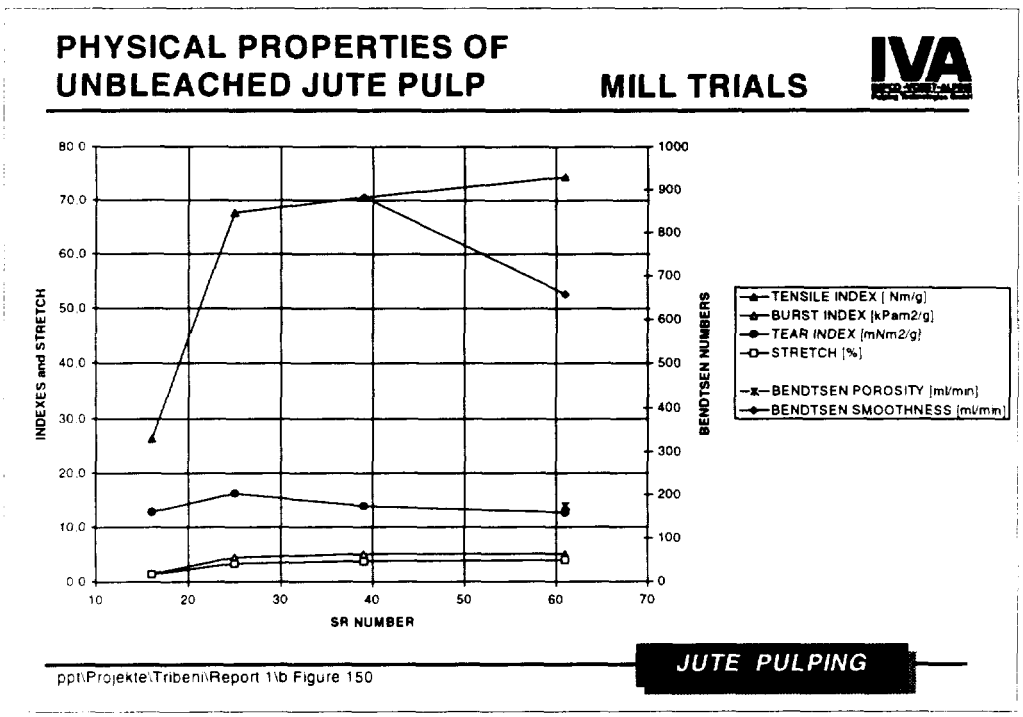
TEAR INDEX [mNm2/g]OF UNBLEACHED KRAFT-AQ JUTE PULP AT 50 SR

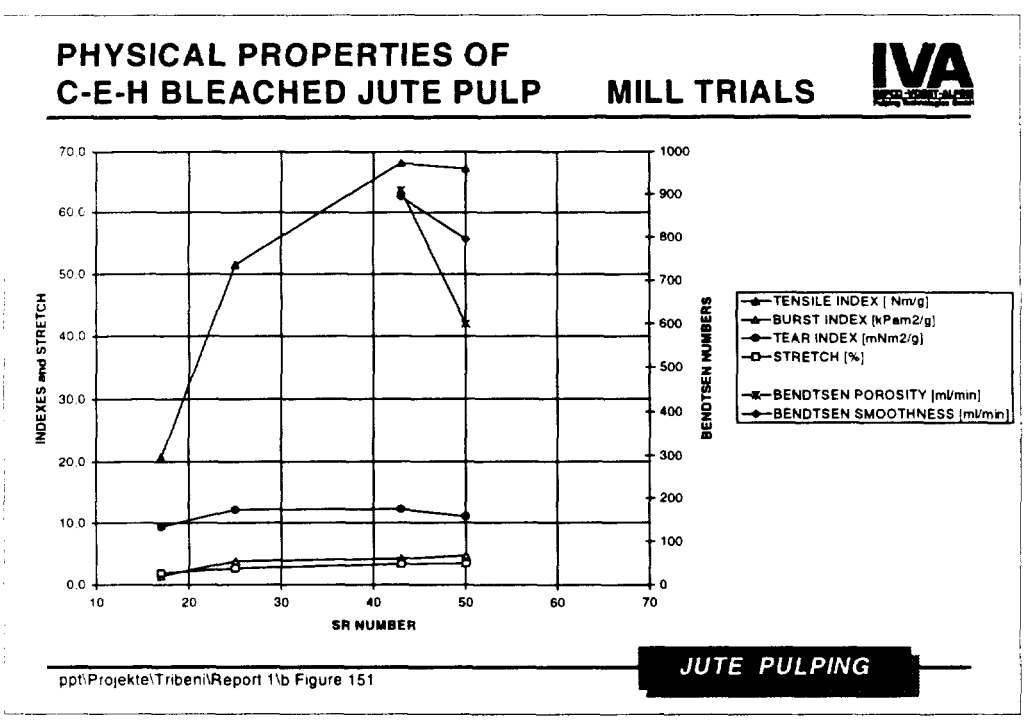


ppt\Projekte\Tribeni\Report 1\b Figure 145

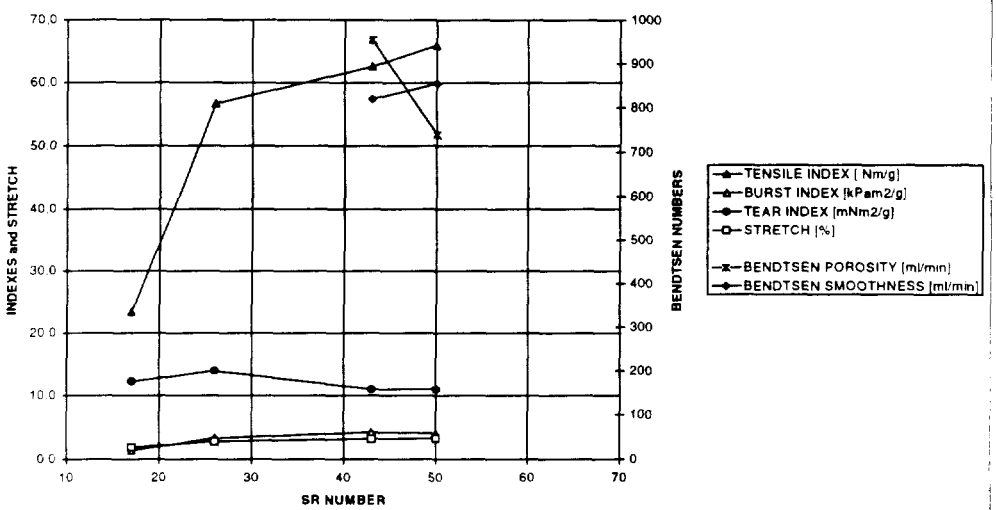
JUTE PULPING

9.2 Bench scale bleaching tests


PHYSICAL PROPERTIES OF
UNBLEACHED JUTE PULP
MILL TRIALS
IVA
INDEXES and STRETCH
BENDTSEN NUMBERS
SR NUMBER
TENSILE INDEX [Nm/g]
BURST INDEX [kPam2/g]
TEAR INDEX [mNm2/g]
STRETCH [%]
BENDTSEN POROSITY [ml/min]
BENDTSEN SMOOTHNESS [ml/min]
ppt\Projekte\Tribeni\Report 1\b Figure 150
JUTE PULPING


PHYSICAL PROPERTIES OF
C-E-H BLEACHED JUTE PULP
MILL TRIALS
IVA
INDEXES and STRETCH
BENDTSEN NUMBERS
SR NUMBER
TENSILE INDEX [Nm/g]
BURST INDEX [kPam2/g]
TEAR INDEX [mNm2/g]
STRETCH [%]
BENDTSEN POROSITY [ml/min]
BENDTSEN SMOOTHNESS [ml/min]
ppt\Projekte\Tribeni\Report 1\b Figure 151
JUTE PULPING

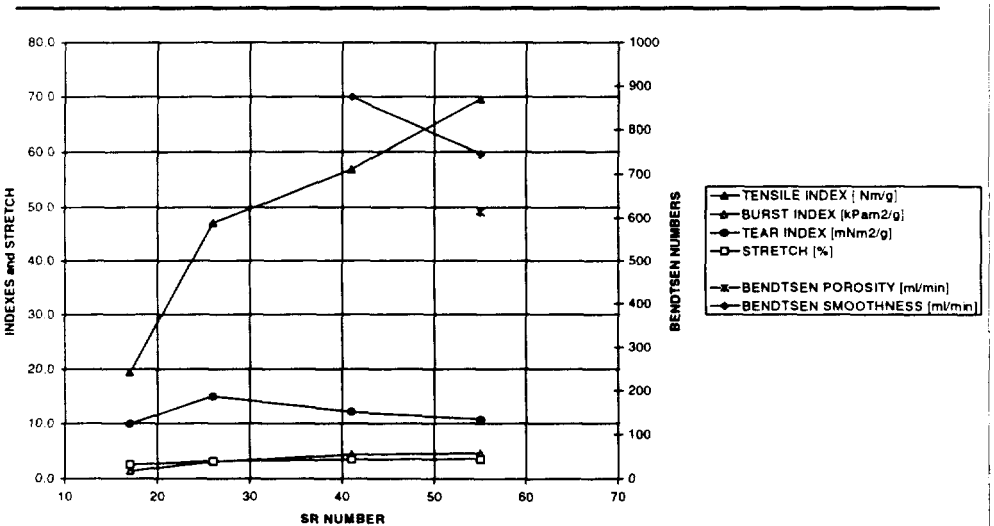
PHYSICAL PROPERTIES OF C-EP-H BLEACHED JUTE PULP MILL TRIALS



ppt\Projekte\Tribeni\Report 1\b Figure 152

JUTE PULPING

PHYSICAL PROPERTIES OF O-C-EO-H BLEACHED JUTE PULP MILL TRIALS



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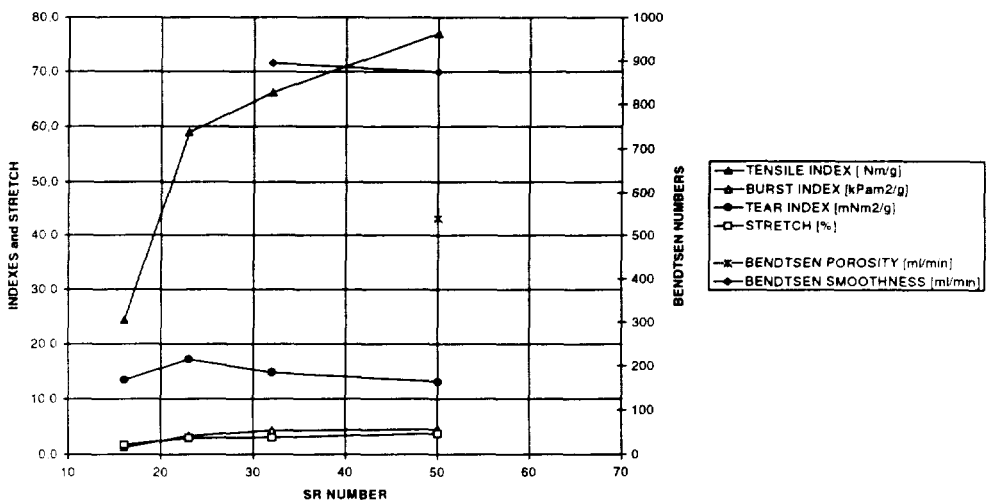
JUTE PULPING

x

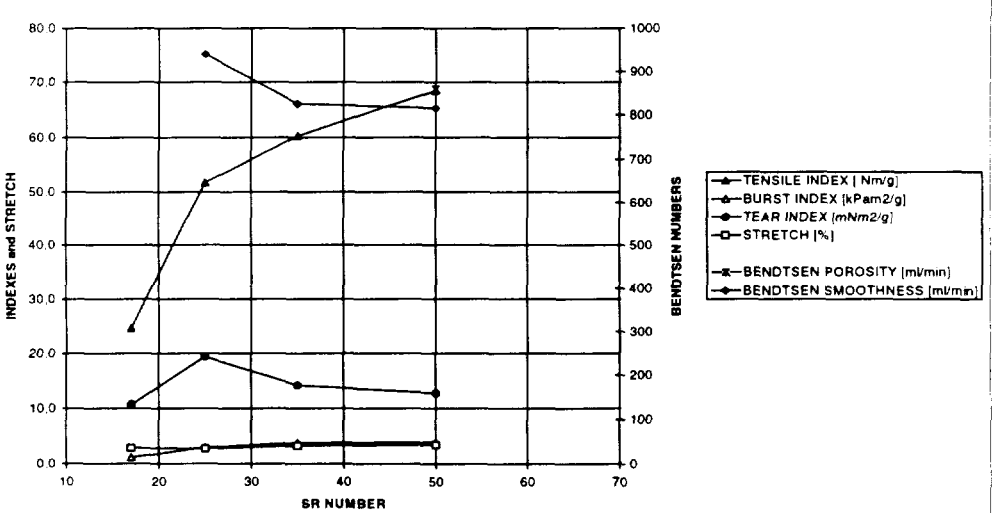
PHYSICAL PROPERTIES OF D-E-D BLEACHED JUTE PULP MILL TRIALS



ppt\Projekte\Tribeni\Report 1\b Figure 154

JUTE PULPING

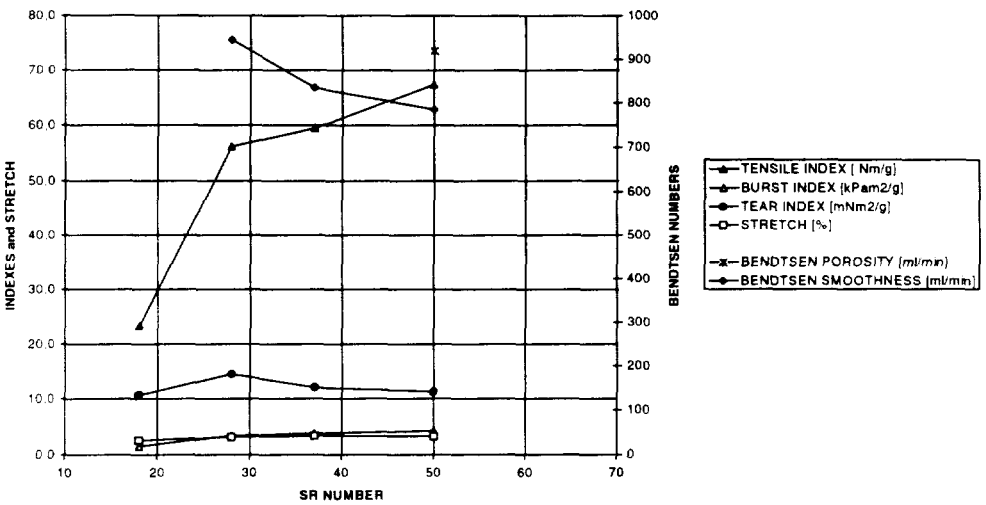
PHYSICAL PROPERTIES OF O-D-EO-D BLEACHED JUTE PULP MILL TRIALS



ppt\Projekte\Tribeni\Report 1\b Figure 155

JUTE PULPING

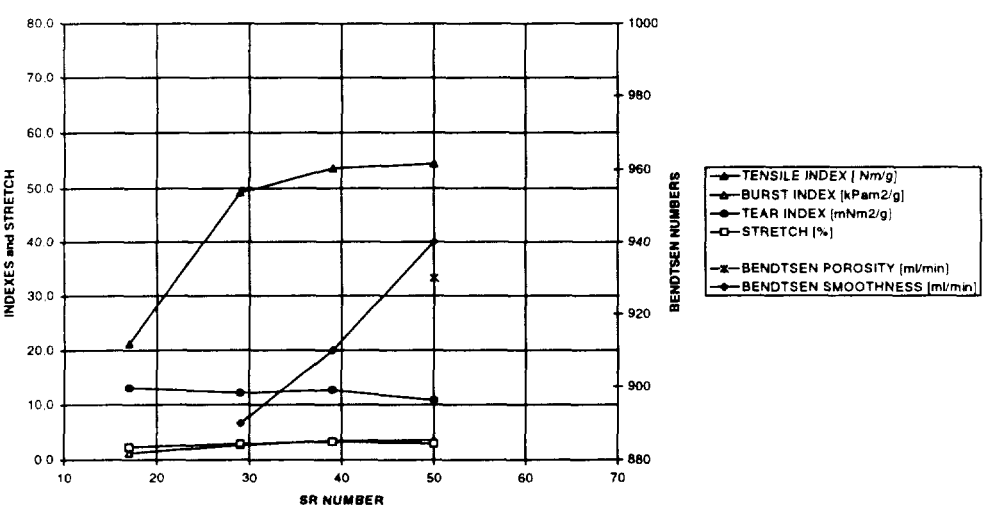
PHYSICAL PROPERTIES OF O-A-EOP-P BLEACHED JUTE PULP MILL TRIALS



ppt\Projekte\Tribeni\Report 1\b Figure 156

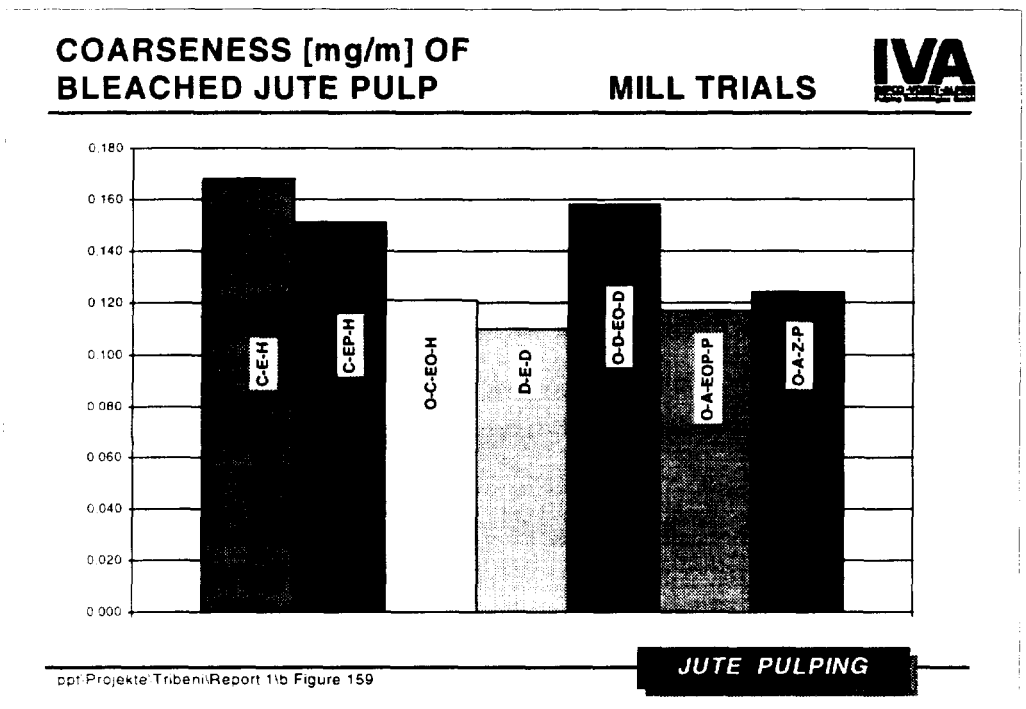
JUTE PULPING

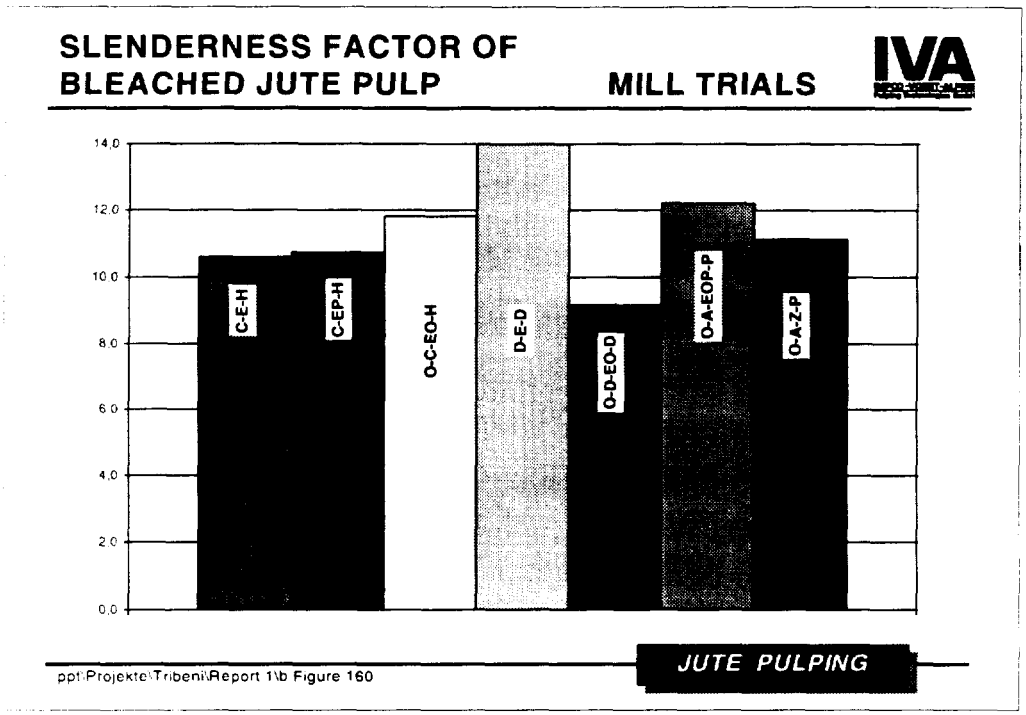
PHYSICAL PROPERTIES OF O-A-Z-P BLEACHED JUTE PULP MILL TRIALS

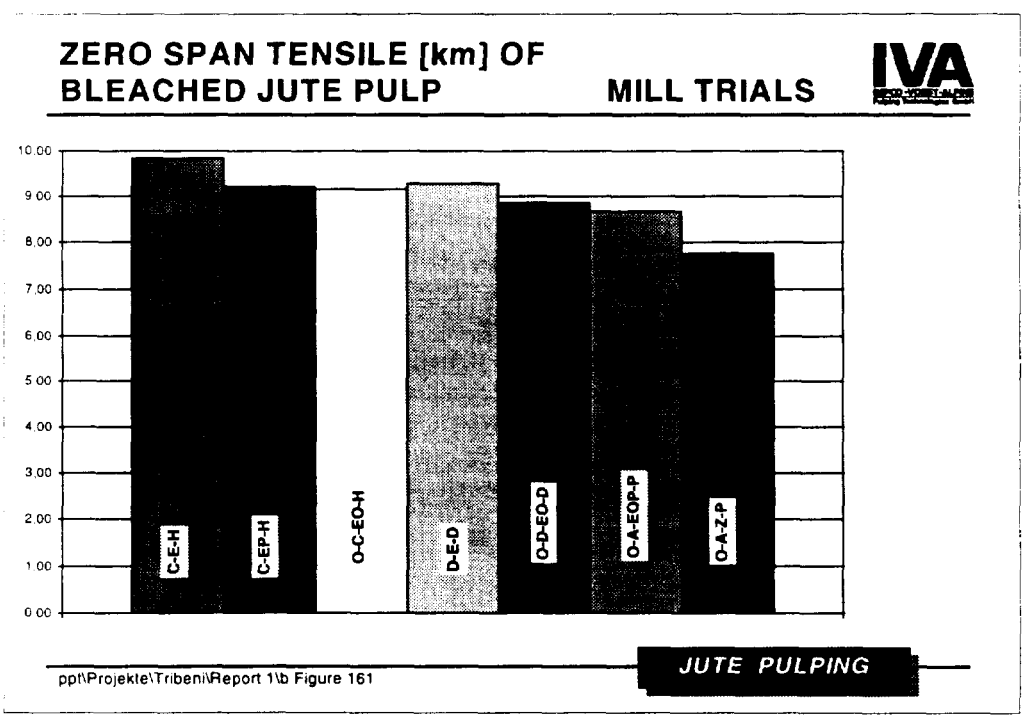


ppt\Projekte\Tribeni\Report 1\b Figure 157

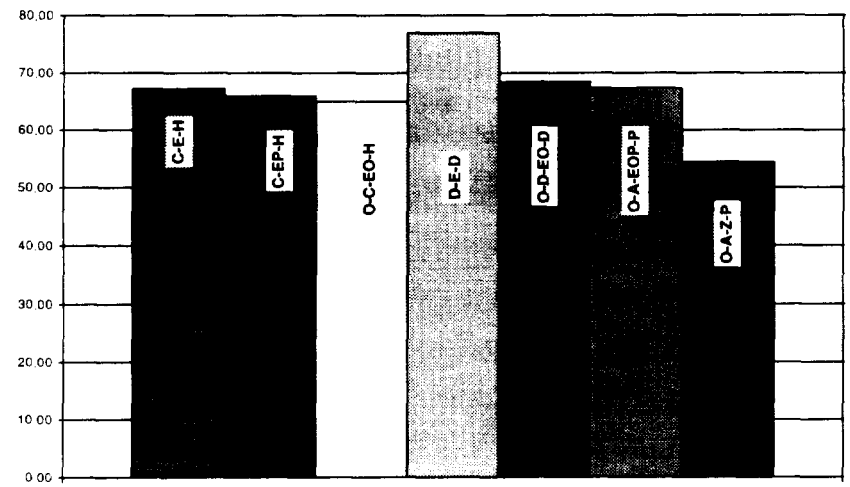
JUTE PULPING


COARSENESS [mg/m] OF
BLEACHED JUTE PULP
MILL TRIALS
IVA
0.180
0.160
0.140
0.120
0.100
0.080
0.060
0.040
0.020
0.000
C-E-H
C-EP-H
O-C-EO-H
D-E-D
O-D-EO-D
O-A-EOP-P
O-A-Z-P
ppt:Projekte\Tribeni\Report 1\b Figure 159
JUTE PULPING


SLENDERNESS FACTOR OF
BLEACHED JUTE PULP
MILL TRIALS
IVA
14,0
12,0
10,0
8,0
6,0
4,0
2,0
0,0
C-E-H
C-EP-H
O-C-EO-H
D-E-D
O-D-EO-D
O-A-EOP-P
O-A-Z-P
ppt\Projekte\Tribeni\Report 1\b Figure 160
JUTE PULPING


ZERO SPAN TENSILE [km] OF
BLEACHED JUTE PULP
MILL TRIALS
IVA
10,00
9,00
8,00
7,00
6,00
5,00
4,00
3,00
2,00
1,00
0,00
C-E-H
C-EP-H
O-C-EO-H
D-E-D
O-D-EO-D
O-A-EOP-P
O-A-Z-P
ppt\Projekte\Tribeni\Report 1\b Figure 161
JUTE PULPING

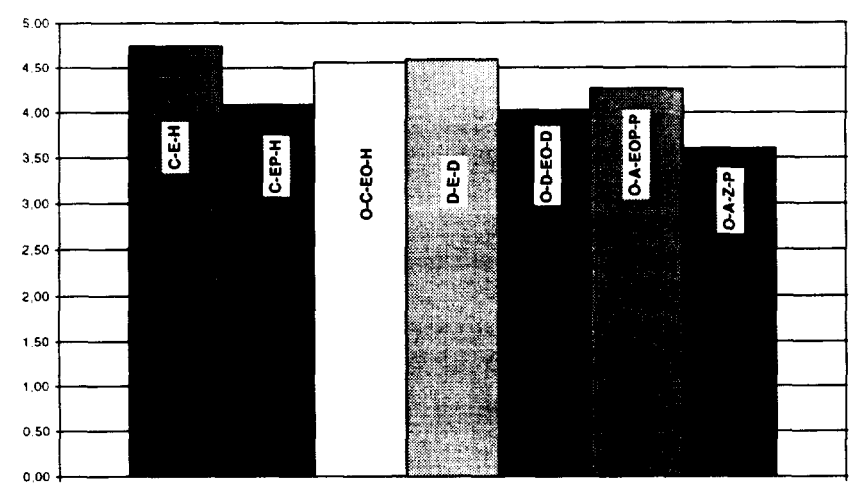
TENSILE INDEX [Nm/g] OF BLEACHED JUTE PULP AT 50 SR MILL TRIALS



ppt\Projekte\Triben\Report 1\b Figure 162

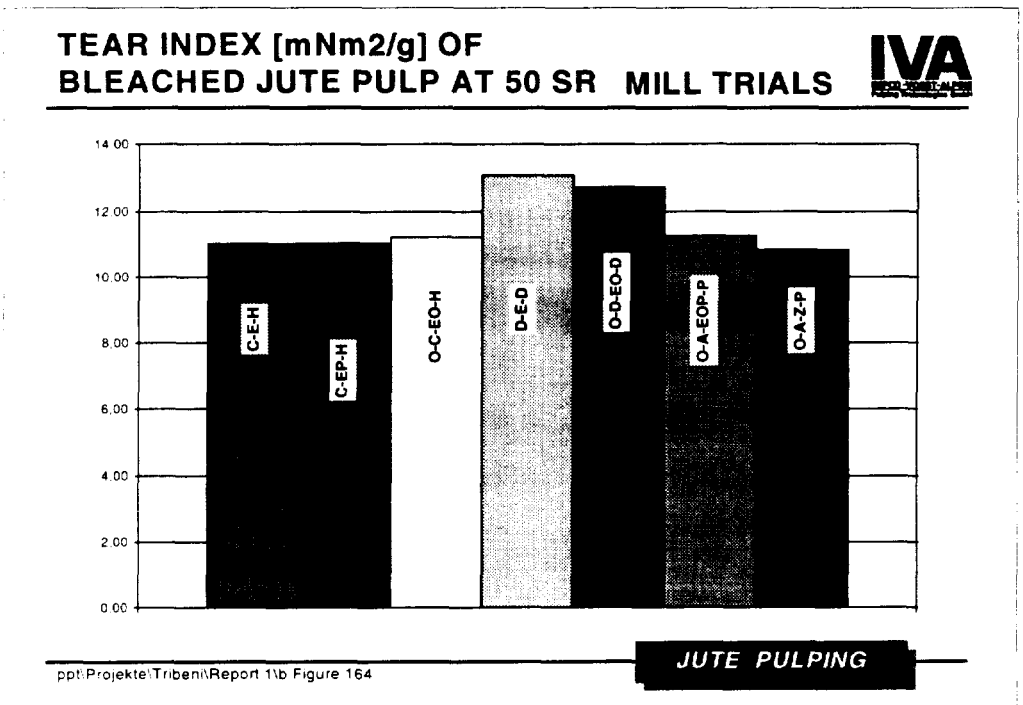
JUTE PULPING

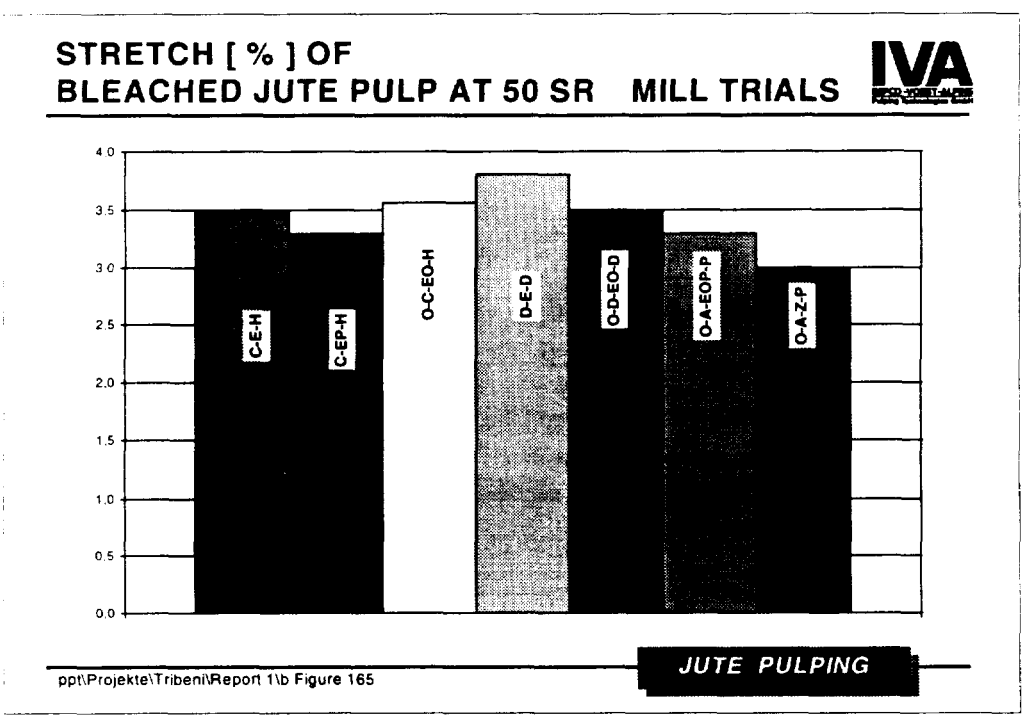
BURST INDEX [kPam2/g] OF BLEACHED JUTE PULP AT 50 SR MILL TRIALS



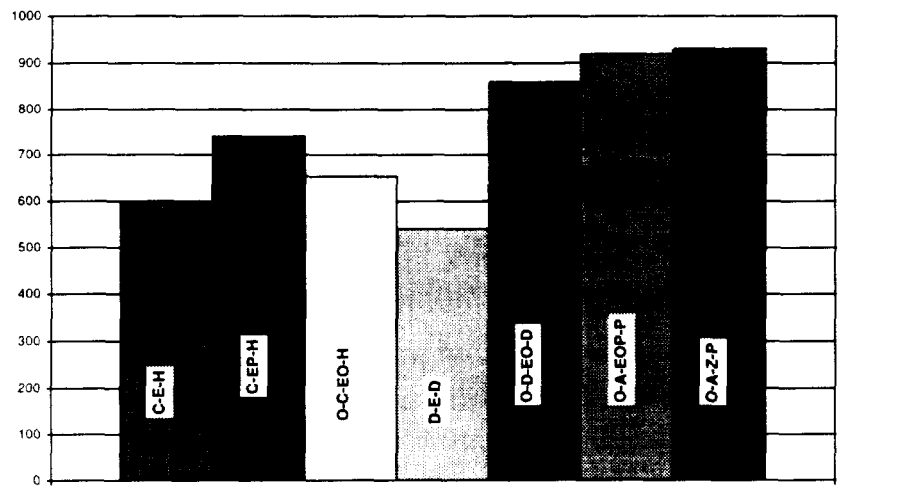
ppt\Projekte\Triben\Report 1\b Figure 163

JUTE PULPING


TEAR INDEX [mNm2/g] OF
BLEACHED JUTE PULP AT 50 SR MILL TRIALS
IVA
14.00
12.00
10.00
8.00
6.00
4.00
2.00
0.00
C-E-H
C-EP-H
O-C-EO-H
D-E-D
O-D-EO-D
O-A-EOP-P
O-A-Z-P
ppt\Projekte\Tribeni\Report 1\b Figure 164
JUTE PULPING


STRETCH [%] OF
BLEACHED JUTE PULP AT 50 SR MILL TRIALS
IVA
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
C-E-H
C-EP-H
O-C-EO-H
D-E-D
O-D-EO-D
O-A-EOP-P
O-A-Z-P
ppt\Projekte\Tribeni\Report 1\b Figure 165
JUTE PULPING

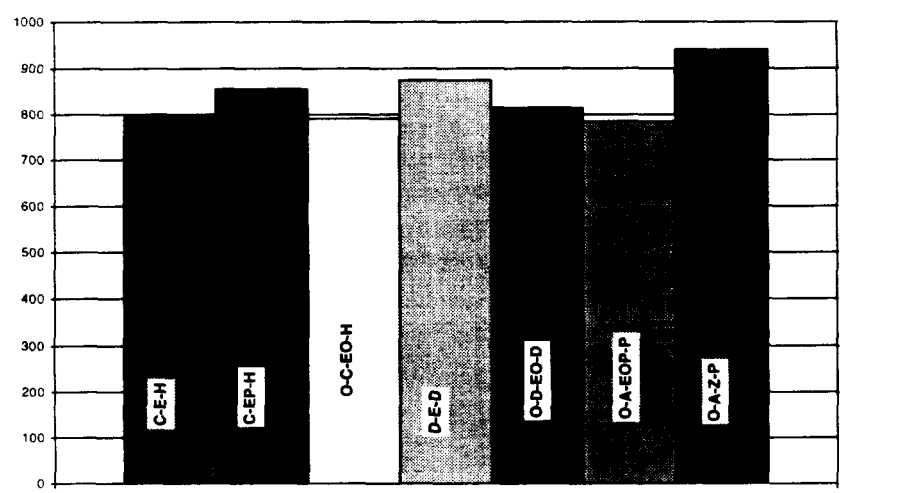
BENDTSEN POROSITY [ml/min] OF BLEACHED JUTE PULP AT 50 SR MILL TRIALS



ppt\Projekte\Tribeni\Report 1\b Figure 166

JUTE PULPING

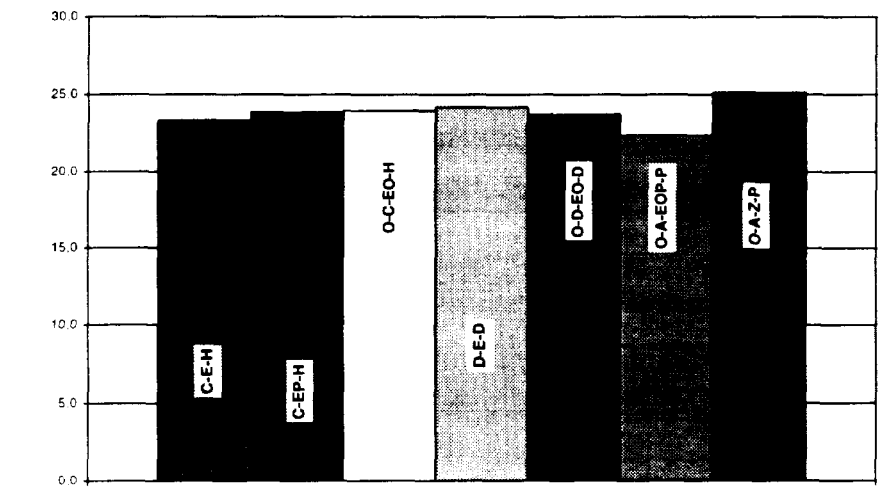
BENDTSEN SMOOTHNESS [ml/min] OF BLEACHED JUTE PULP AT 50 SR MILL TRIALS



ppt\Projekte\Tribeni\Report 1\b Figure 167

JUTE PULPING

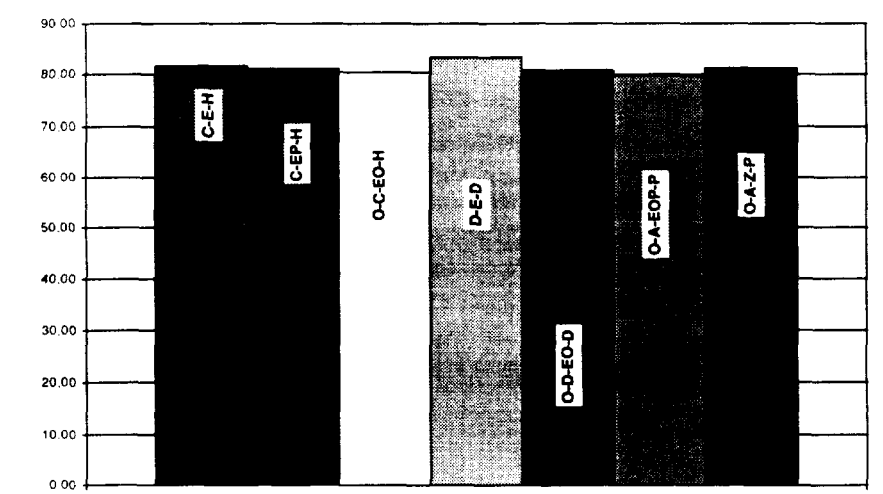
SCATTERING COEFFICIENT [m²/kg] OF BLEACHED JUTE PULP AT 50 SR MILL TRIALS



ppt\Projekte\Tribeni\Report 1\b Figure 168

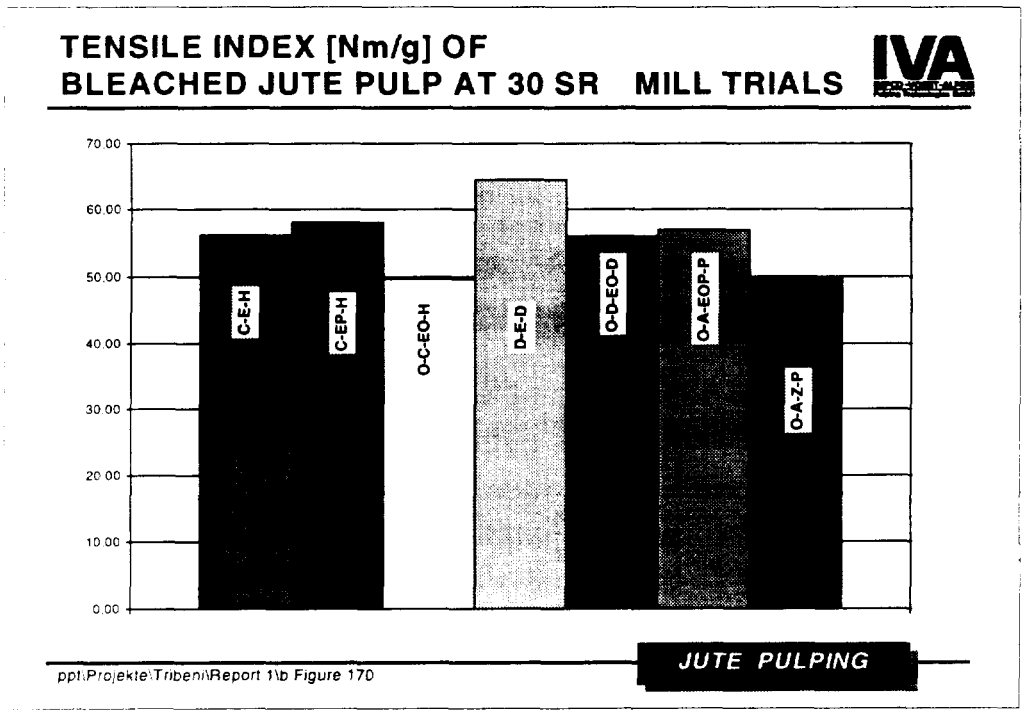
JUTE PULPING

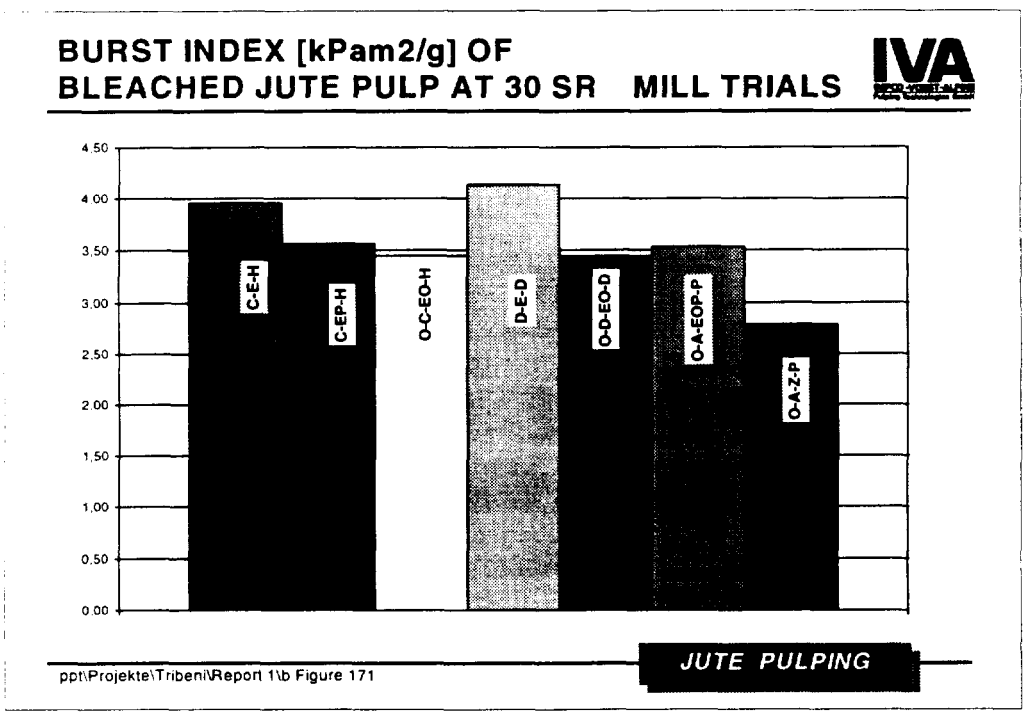
OPACITY [%] OF BLEACHED JUTE PULP AT 50 SR MILL TRIALS



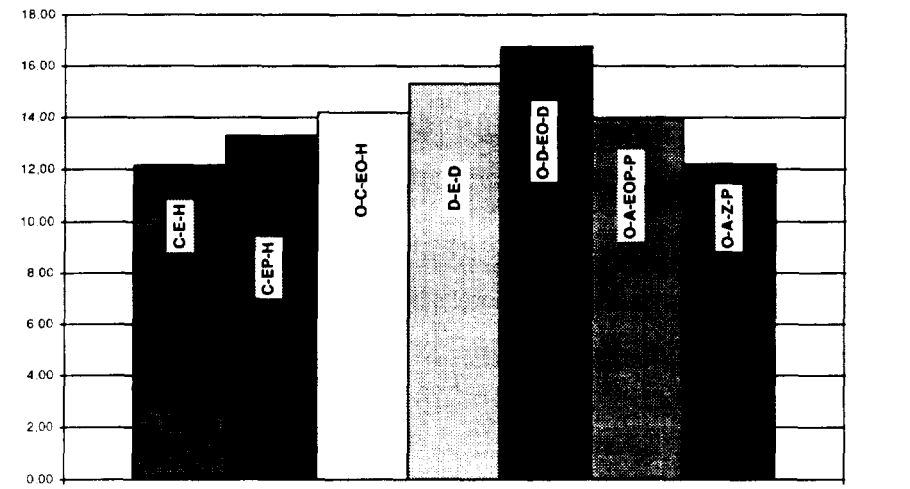
ppt\Projekte\Tribeni\Report 1\b Figure 169

JUTE PULPING


TENSILE INDEX [Nm/g] OF
BLEACHED JUTE PULP AT 30 SR MILL TRIALS
IVA
70.00
60.00
50.00
40.00
30.00
20.00
10.00
0.00
C-E-H
C-EP-H
O-C-EO-H
D-E-D
O-D-EO-D
O-A-EOP-P
O-A-Z-P
ppt\Projekte\Tribeni\Report 1\b Figure 170
JUTE PULPING


BURST INDEX [kPam2/g] OF
BLEACHED JUTE PULP AT 30 SR MILL TRIALS
IVA
4.50
4.00
3.50
3.00
2.50
2.00
1.50
1.00
0.50
0.00
C-E-H
C-EP-H
O-C-EO-H
D-E-D
O-D-EO-D
O-A-EOP-P
O-A-Z-P
ppt\Projekte\Tribeni\Report 1\b Figure 171
JUTE PULPING

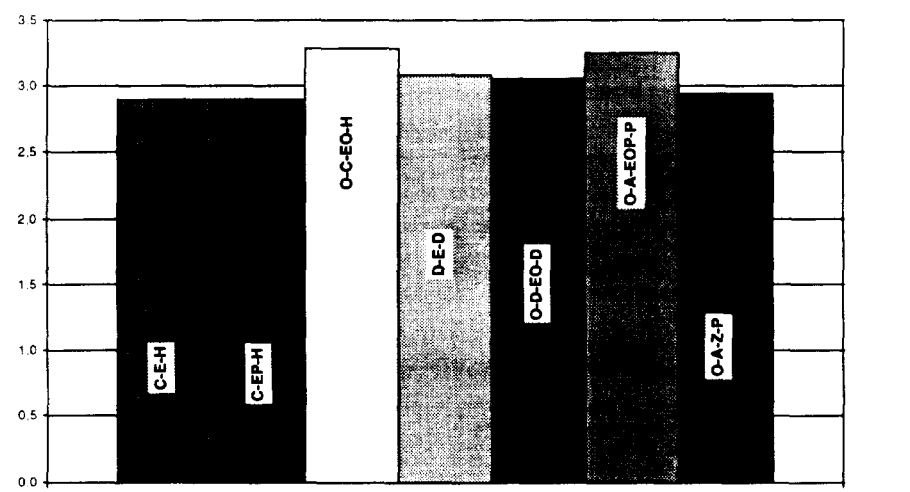
TEAR INDEX [mNm2/g] OF BLEACHED JUTE PULP AT 30 SR MILL TRIALS



ppt\Projekte\Tribeni\Report 1\b Figure 172

JUTE PULPING

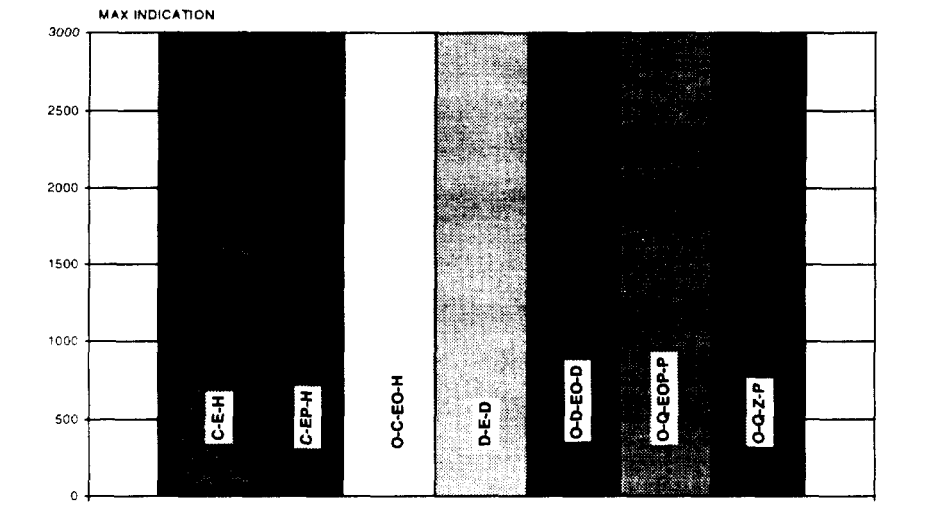
STRETCH [%] OF BLEACHED JUTE PULP AT 30 SR MILL TRIALS



ppt\Projekte\Tribeni\Report 1\b Figure 173

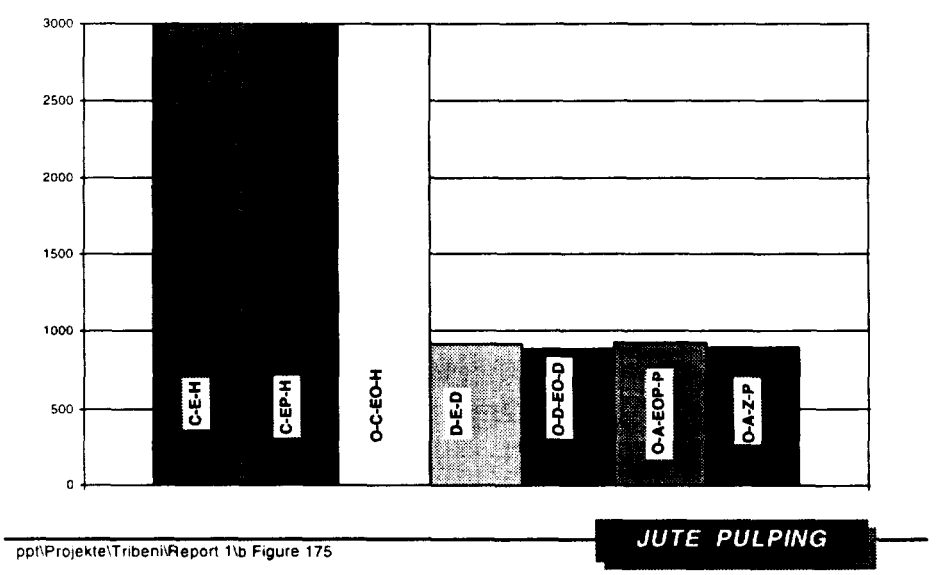
JUTE PULPING

BENDTSEN POROSITY [ml/min] OF BLEACHED JUTE PULP AT 30 SR MILL TRIALS



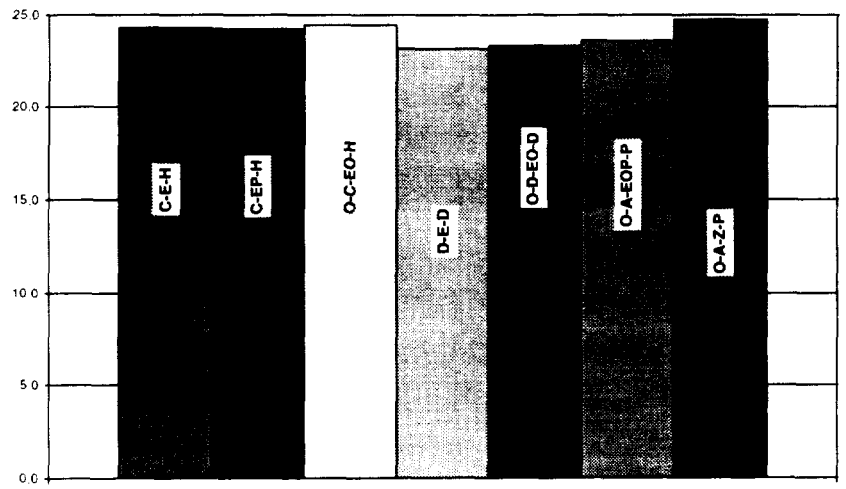
ppt\Projekte\Tribeni\Report 1\b Figure 174

BENDTSEN SMOOTHNESS [ml/min] OF BLEACHED JUTE PULP AT 30 SR MILL TRIALS



ppt\Projekte\Tribeni\Report 1\b Figure 175

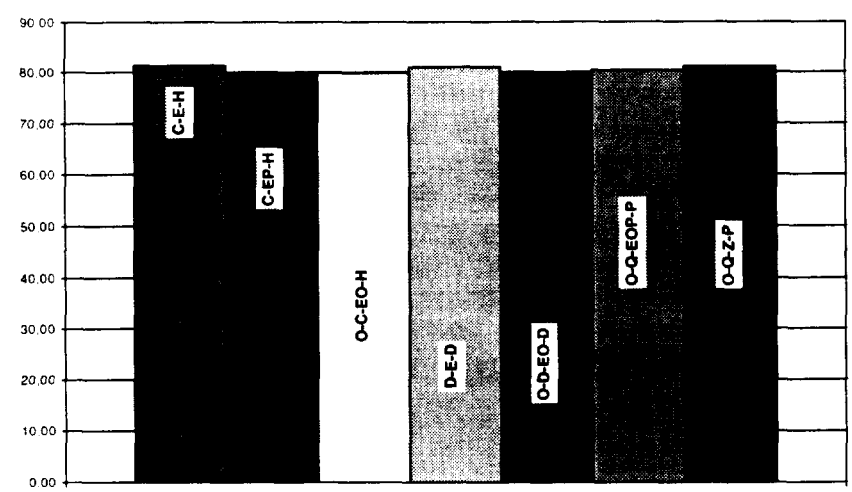
SCATTERING COEFFICIENT [ ] OF BLEACHED JUTE PULP AT 30 SR MILL TRIALS



ppt\Projekte\Tribeni\Report 1\b Figure 176

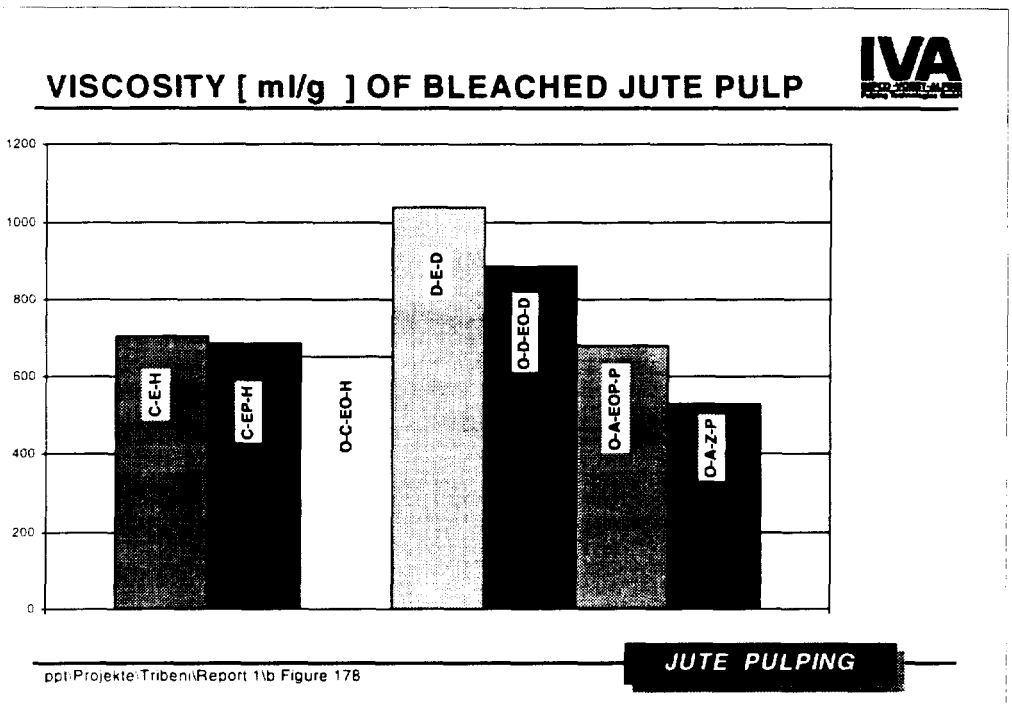
JUTE PULPING

OPACITY [%] OF BLEACHED JUTE PULP AT 30 SR MILL TRIALS



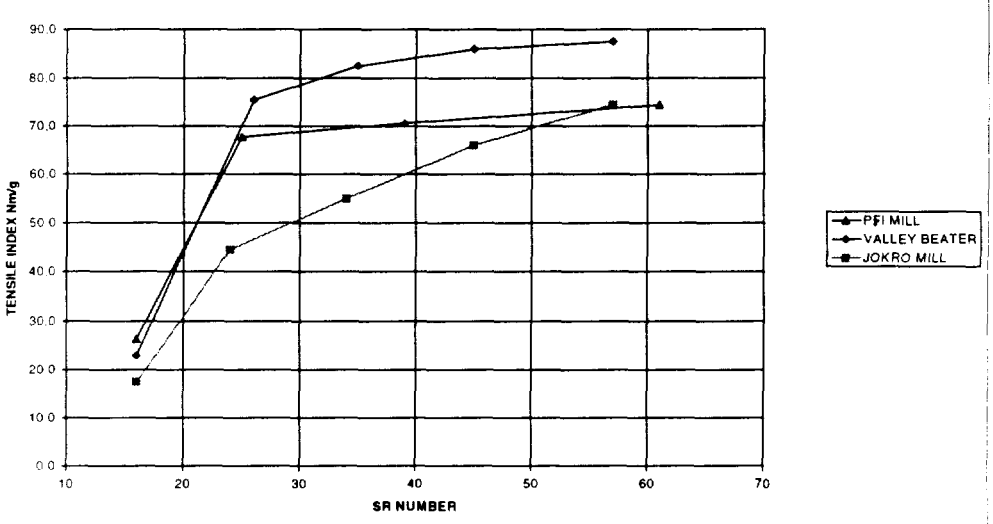
ppt\Projekte\Tribeni\Report 1\b Figure 177

JUTE PULPING


VISCOSITY [ml/g] OF BLEACHED JUTE PULP
IVA
1200
1000
800
600
400
200
0
C-E-H
C-EP-H
O-C-EO-H
D-E-D
O-D-EO-D
O-A-EOP-P
O-A-Z-P
ppt\Projekte\Tribeni\Report 1\b Figure 178
JUTE PULPING

9.3 Comparison of different beating equipment

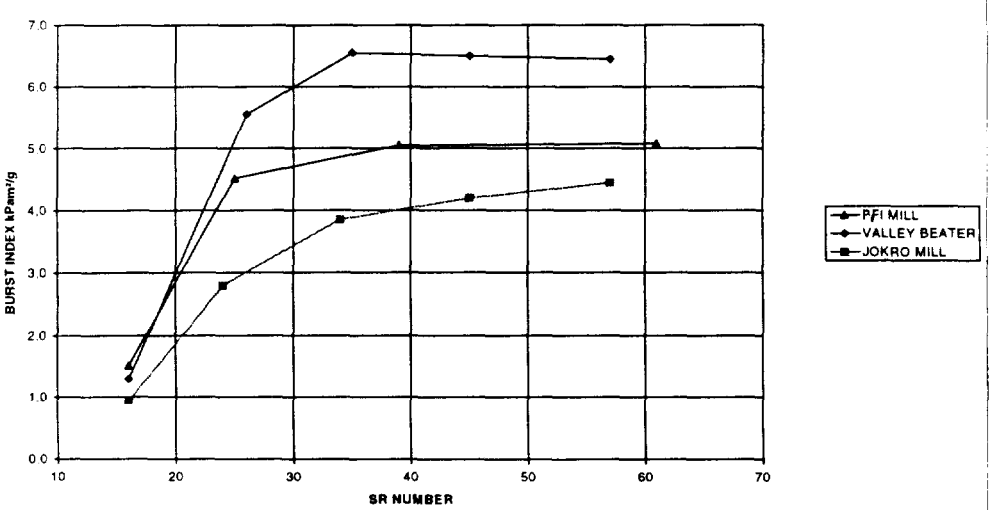
TENSILE INDEX [Nm/g] OF MILL TRIALS UNBLEACHED KRAFT-AQ JUTE PULP



ppt\Projekte\Tribeni\Report 1\b Figure 179

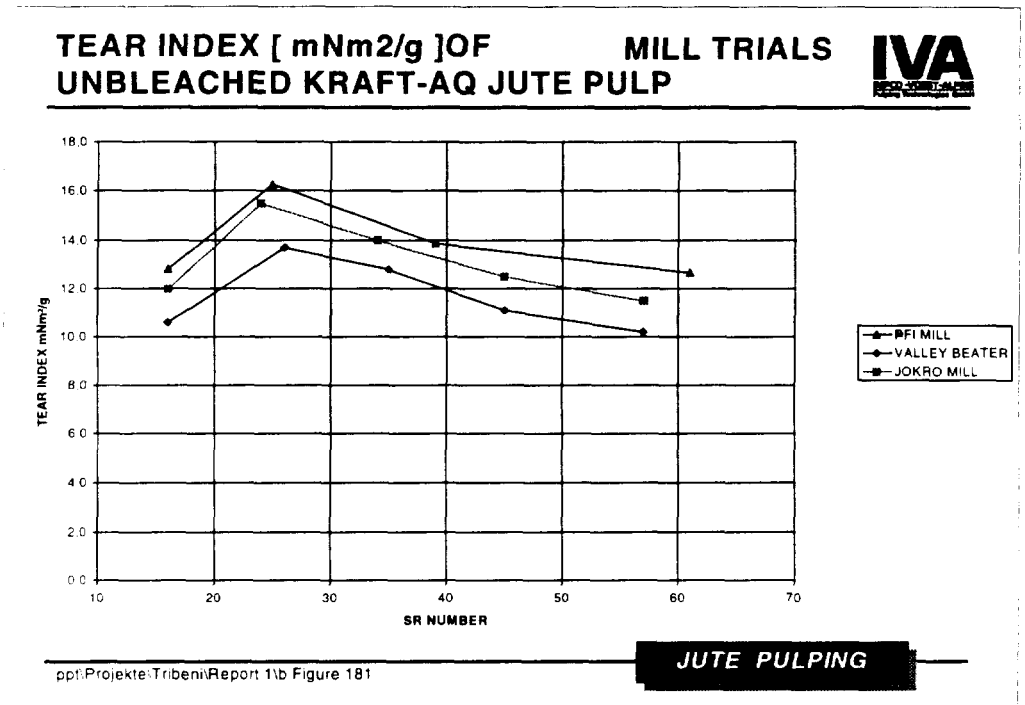
JUTE PULPING

BURST INDEX [kPam2/g]OF MILL TRIALS UNBLEACHED KRAFT-AQ JUTE PULP



ppt\Projekte\Tribeni\Report 1\b Figure 180

JUTE PULPING


TEAR INDEX [mNm2/g]OF MILL TRIALS
UNBLEACHED KRAFT-AQ JUTE PULP
IVA
18.0
16.0
14.0
12.0
10.0
8.0
6.0
4.0
2.0
0.0
TEAR INDEX mNm²/g
10
20
30
40
50
60
70
SR NUMBER
PFI MILL
VALLEY BEATER
JOKRO MILL
ppt\Projekte\Tribeni\Report 1\b Figure 181
JUTE PULPING

FIBRE DISTRIBUTION AND ANALYSIS OF UNBLEACHED JUTE PULP

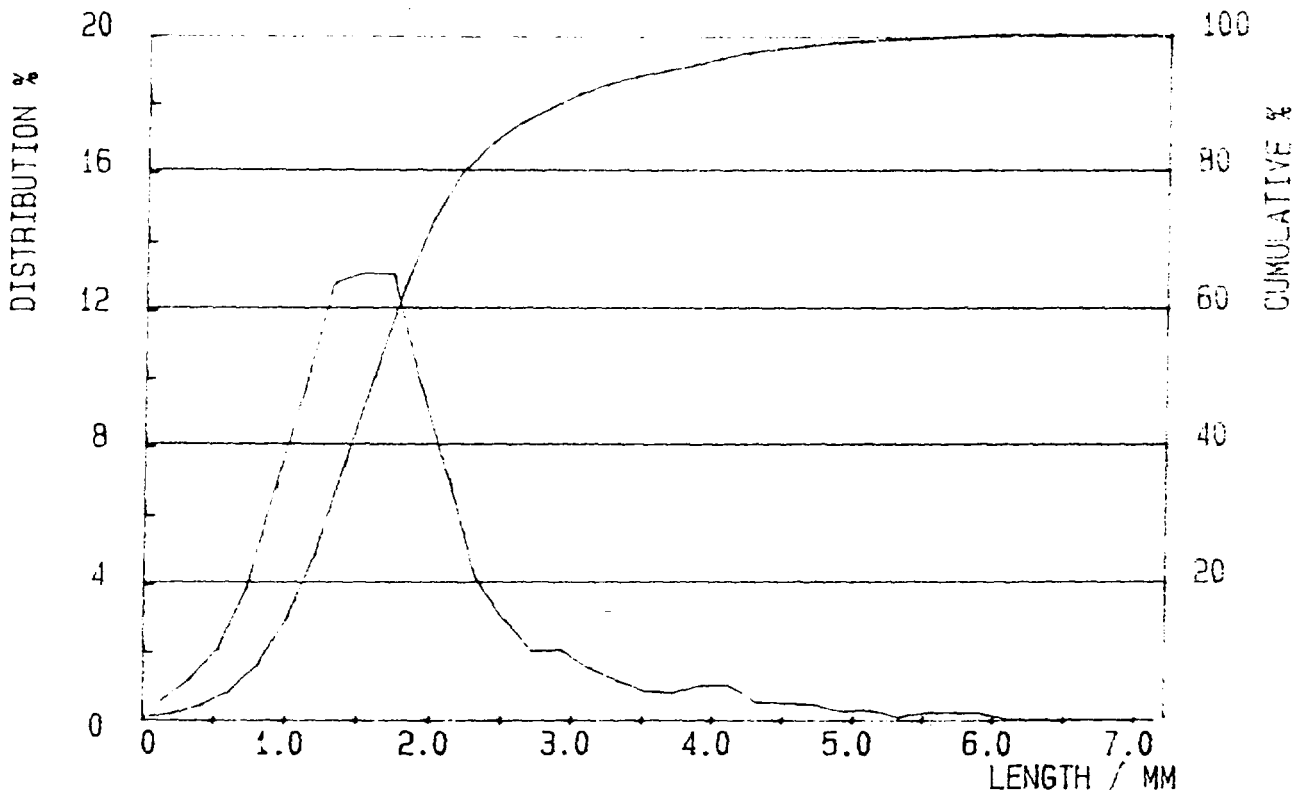
WITH

KAJAANI FS-200

KAJAANI FS-200 14-02-95 10: 29

WEIGHTED DISTRIBUTION

SAMPLE TITLE	N/42/96 NEB JUTE (UNBLEACHED)	SAMPLE FILE NO	006
SAMPLED	14-07-95	UPPER LIMIT	6.00
ANALYSED	14-02-95 09: 51	LOWER LIMIT	0.00
TOTAL FIBERS	12755	WEIGHT	7.14 mg



ARITHMETIC AV	1.25 mm	COARSENESS	0.173 mg/m
L WEIGHTED AV	1.75 mm	WOOD SPEC	0.0 %
W WEIGHTED AV	2.21 mm	CUSTOM /L VALUE OUT OF TABLE	

LENGTH 0.20 mm P= 9.21 % W= 0.55 %

FIBRE DISTRIBUTION AND ANALYSIS OF BLEACHED JUTE PULP

WITH

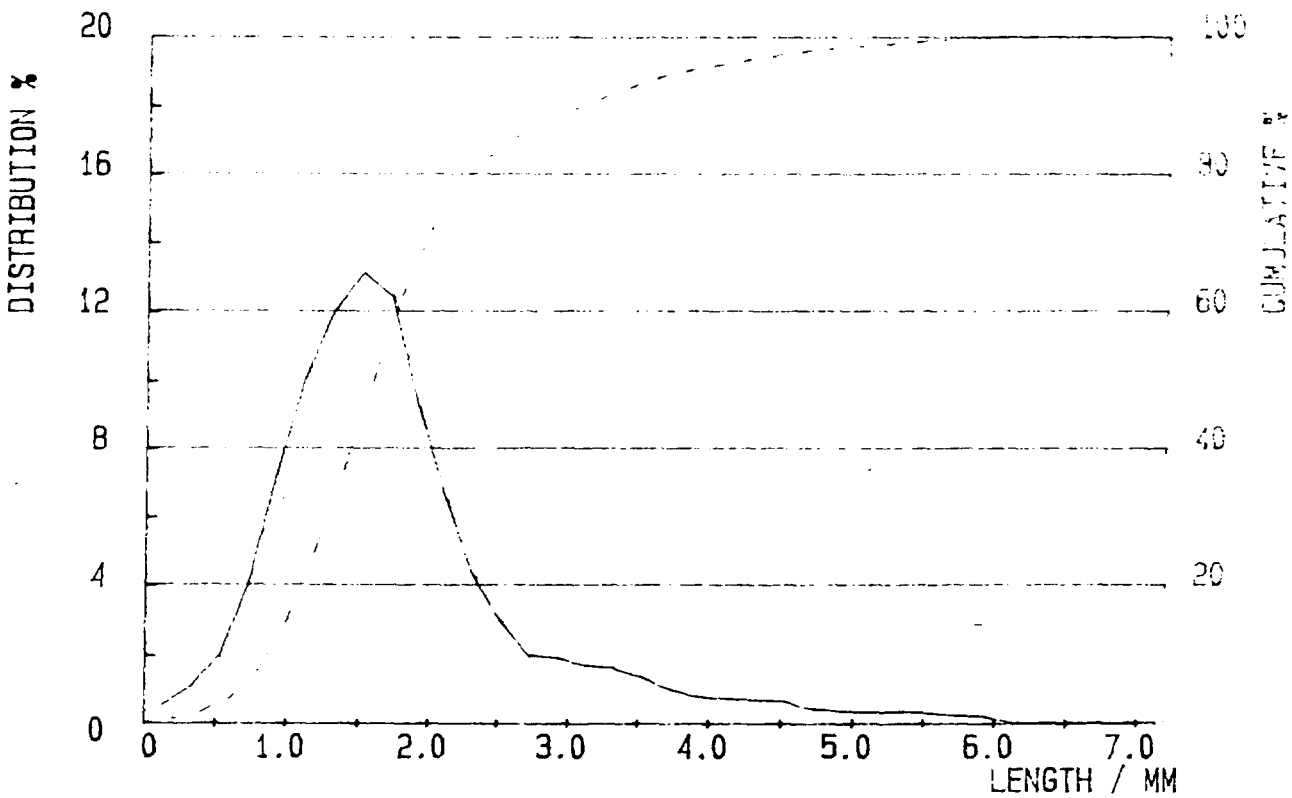
KAJAANI FS-200

BLEACHING TRIALS

KAJAANI FS-200 20-03-95 09:01

WEIGHTED DISTRIBUTION

SAMPLE TITLE	N/42/96 A 515 (C-E-H)	SAMPLE FILE NO	007
SAMPLED	18-03-96	UPPER LIMIT	6.00
ANALYSED	20-03-95 08:54	LOWER LIMIT	0.00
TOTAL FIBERS	14911	WEIGHT	8.02 mg



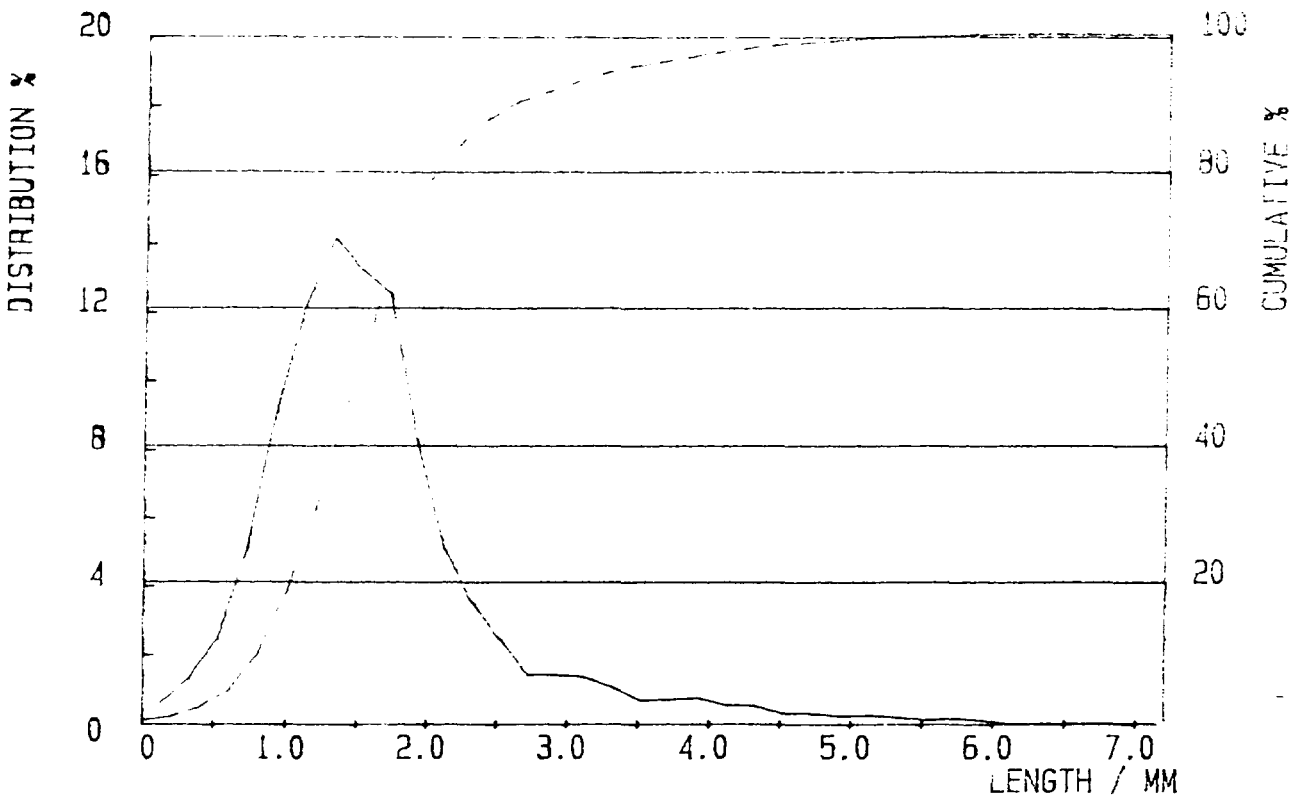
ARITHMETIC AV	1.26 mm	COARSENESS	0.168 mg/m
L WEIGHTED AV	1.78 mm	WOOD SPEC	0.0 %
W WEIGHTED AV	2.28 mm	CUSTOM /L VALUE OUT OF TABLE	

LENGTH 0:20 mm P= 8.86 % W= 0.52 %

KAJAANI FS-200 21-03-95 08:53

WEIGHTED DISTRIBUTION

SAMPLE TITLE	N/42/96 A 516 (C-EP-H)	SAMPLE FILE NO	008
SAMPLED	20-03-96	UPPER LIMIT	6.00
ANALYSED	21-03-95 08:48	LOWER LIMIT	0.00
TOTAL FIBERS	17185	WEIGHT	7.94 mg



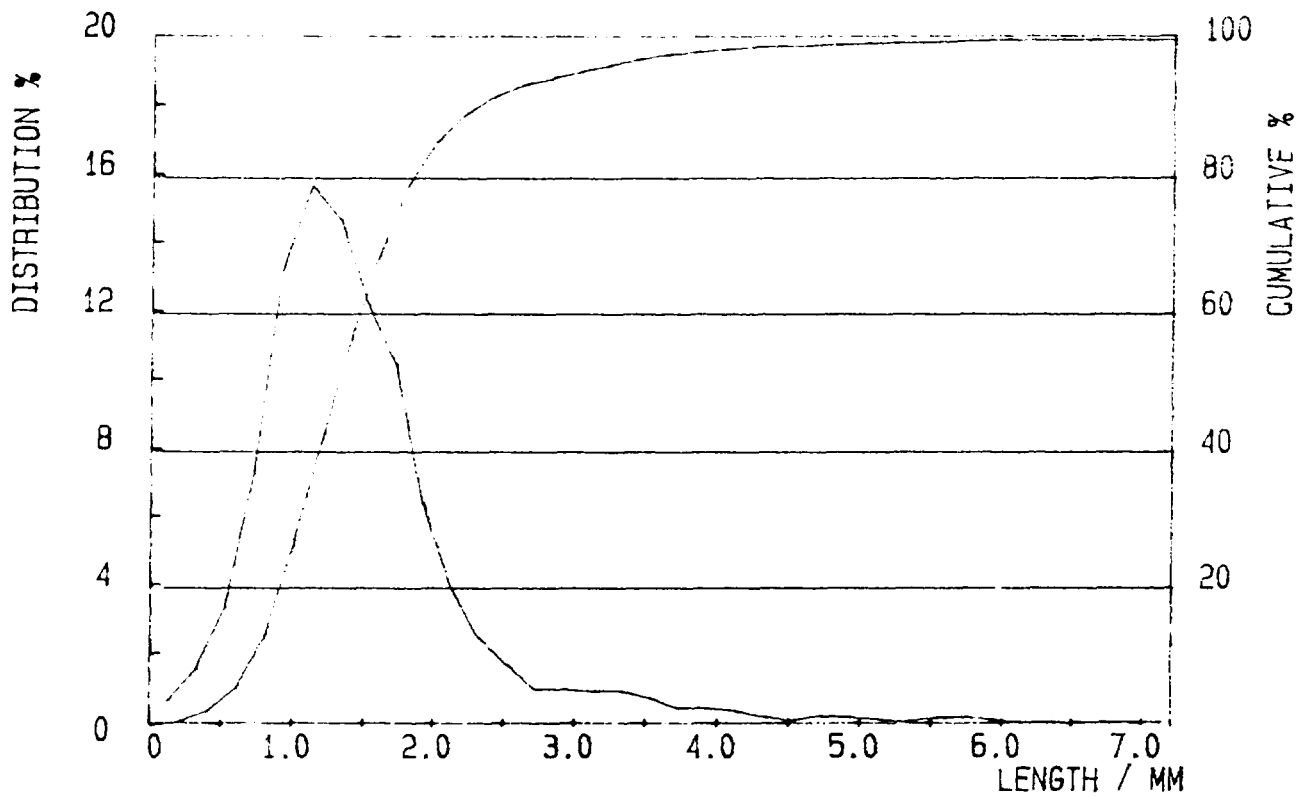
ARITHMETIC AV	1.17 mm	COARSENESS	0.151 mg/m
L WEIGHTED AV	1.62 mm	WOOD SPEC	0.0 %
W WEIGHTED AV	2.06 mm	CUSTOM /L VALUE OUT OF TABLE	

LENGTH 0.20 mm P= 8.83 % W= 0.58 %

KAJAANI FS-200 22-03-95 09:00

WEIGHTED DISTRIBUTION

SAMPLE TITLE	N/42/96 A 518 (O-C-EO-H)	SAMPLE FILE NO	009
SAMPLED	21-03-96	UPPER LIMIT	6.00
ANALYSED	22-03-95 08:58	LOWER LIMIT	0.00
TOTAL FIBERS	23262	WEIGHT	/.80 mg

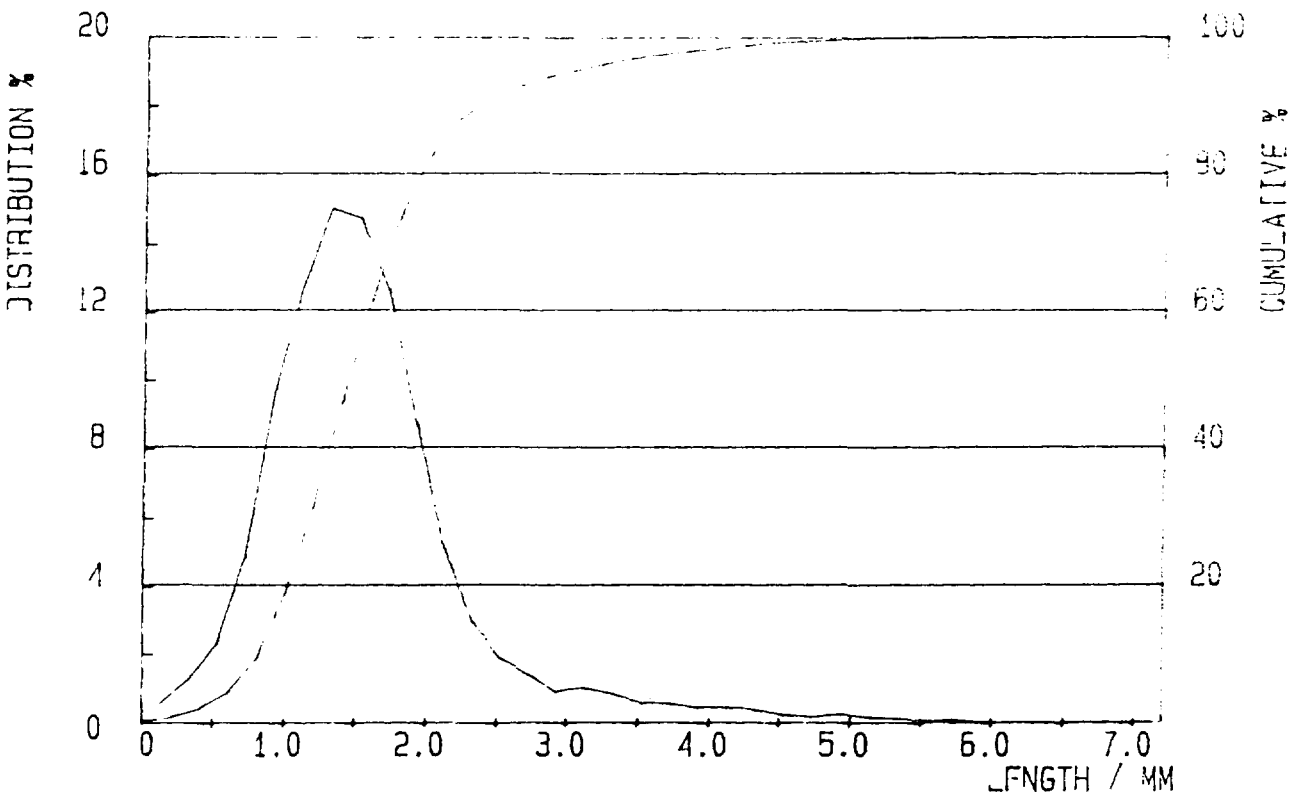


ARITHMETIC AV	1.05 mm	COARSENESS	0.121 mg/m
L WEIGHTED AV	1.43 mm	WOOD SPEC	0.0 %
W WEIGHTED AV	1.82 mm	CUSTOM /L VALUE OUT OF TABLE	
LENGTH 0.20 mm	P= 8.33 %	W= 0.62 %	

KAJAANI FS-200 05-04-95 07:33

WEIGHTED DISTRIBUTION

SAMPLE TITLE	N/12/96 \ 524 (D-E-D)	SAMPLE FILE NO	013
SAMPLED	04-04-96	UPPER LIMIT	6.00
ANALYSED	05-04-95 07:31	LOWER LIMIT	0.00
TOTAL FIBERS	22258	WEIGHT	1.54 mg

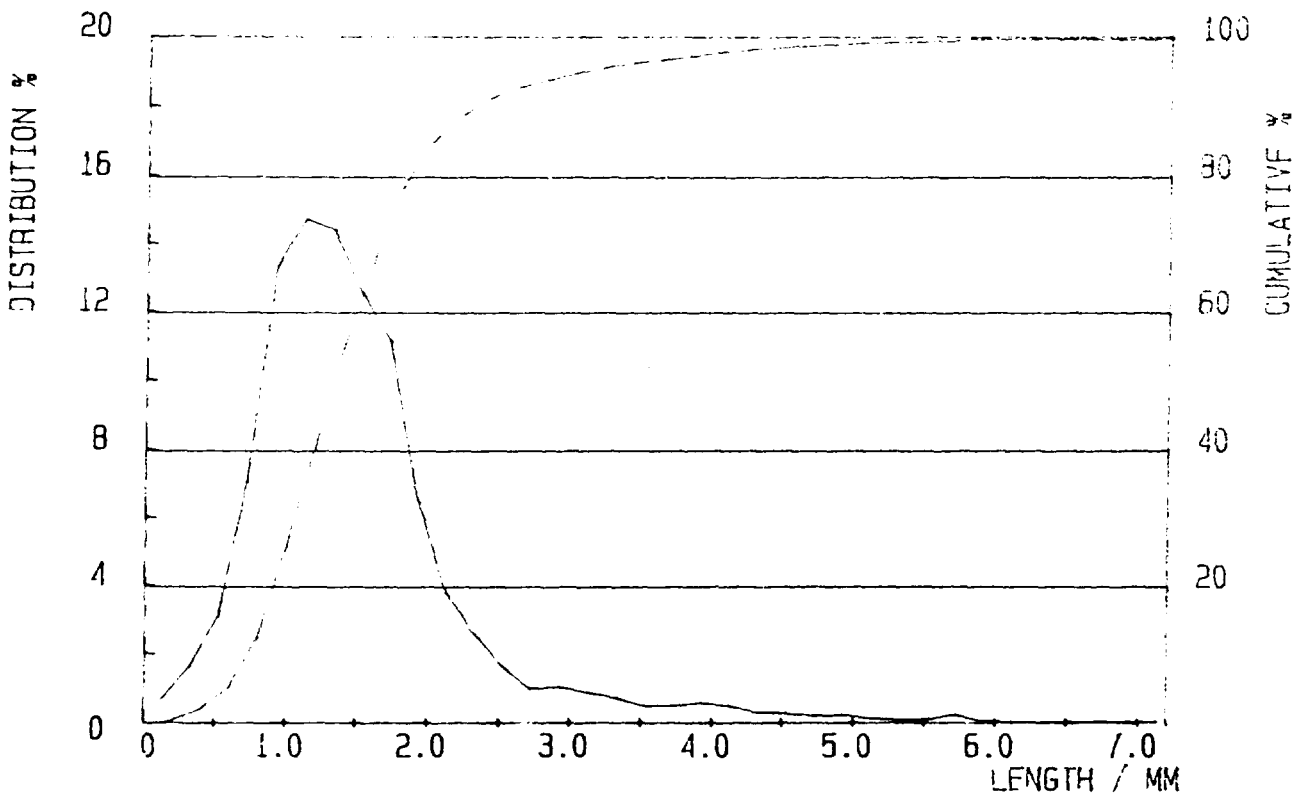


ARITHMETIC AV	1.16 mm	COARSENESS	0.110 mg/m
L WEIGHTED AV	1.54 mm	WOOD SPEC	0.0 %
W WEIGHTED AV	1.90 mm	CUSTOM L VALUE OUT OF TABLE	
LENGTH 0.20 mm P=	1.57 % W=	0.53 %	

KAJAANI FS-200 26-03-95 08: 57

WEIGHTED DISTRIBUTION

SAMPLE TITLE	N/42/96 A 519 (O-D-EO-O)	SAMPLE FILE NO	010
SAMPLED	25-03-96	UPPER LIMIT	6.00
ANALYSED	26-03-95 08: 45	LOWER LIMIT	0.00
TOTAL FIBERS	17247	WEIGHT	7.67 mg



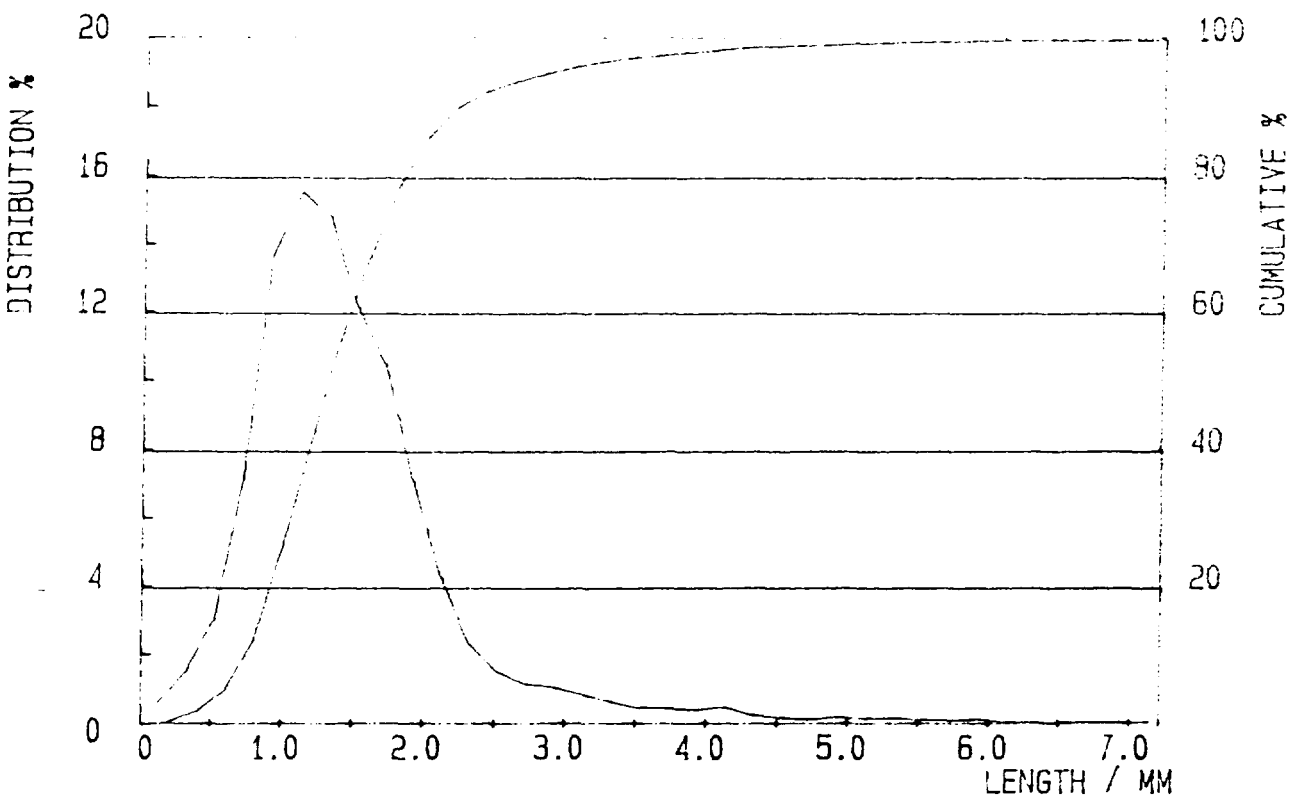
ARITHMETIC AV	1.06 mm	COARSENESS	0.158 mg/m
L WEIGHTED AV	1.45 mm	WOOD SPEC	0.0 %
W WEIGHTED AV	1.87 mm	CUSTOM /L VALUE OUT OF TABLE	

LENGTH 0.20 mm P= 8.87 % W= 0.66 %

KAJAANI FS-200 27-03-95 08:59

WEIGHTED DISTRIBUTION

SAMPLE TITLE	N/42/96 A 520 (O-A-EOP-P)	SAMPLE FILE NO	011
SAMPLED	26-03-96	UPPER LIMIT	6.00
ANALYSED	27-03-95 08:57	LOWER LIMIT	0.00
TOTAL FIBERS	23026	WEIGHT	7.70 mg



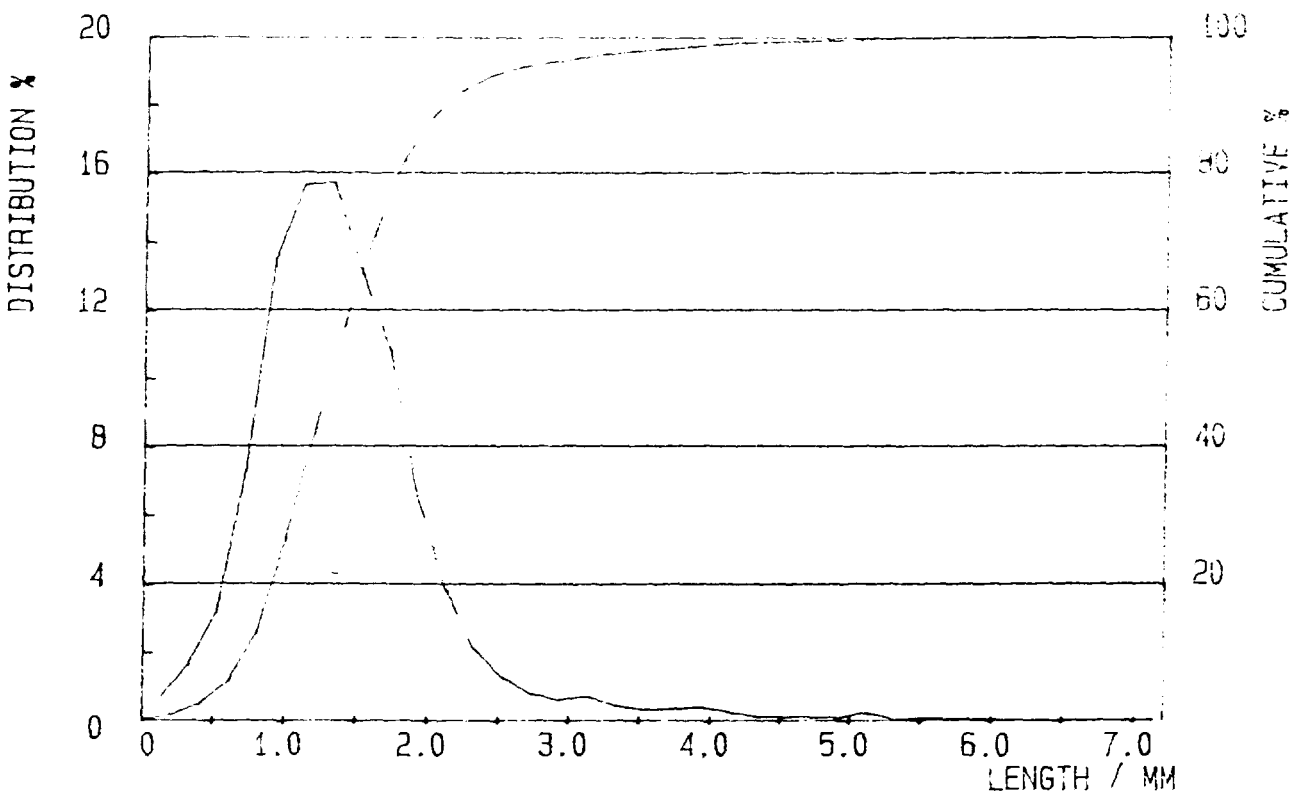
ARITHMETIC AV	1.07 mm	COARSENESS	0.117 mg/m
L WEIGHTED AV	1.43 mm	WOOD SPEC	0.0 %
W WEIGHTED AV	1.80 mm	CUSTOM /L VALUE OUT OF TABLE	

LENGTH 0.20 mm P= 7.62 % W= 0.59 %

KAJAANI FS-200 28-03-95 08:53

WEIGHTED DISTRIBUTION

SAMPLE TITLE	N/42/96 A 521 (O-A-Z-P)	SAMPLE FILE NO	012
SAMPLED	2/-03-96	UPPER LIMIT	6.00
ANALYSED	28-03-95 08:37	LOWER LIMIT	0.00
TOTAL FIBERS	21026	WEIGHT	7.64 mg



ARITHMETIC AV	1.04 mm	COARSENESS	0.124 mg/m
L WEIGHTED AV	1.38 mm	WOOD SPEC	0.0 %
W WEIGHTED AV	1.71 mm	CUSTOM /L VALUE OUT OF TABLE	

LENGTH 0.20 mm P= 8.35 % W= 0.63 %