

PROCESS FOR THE PRODUCTION OF DISSOLVING PULP FROM *TREMA ORIENTALIS* (NALITA) BY PREHYDROLYSIS KRAFT AND SODA-ETHYLENEDIAMINE (EDA) PROCESS

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This paper presents a preliminary study for the production of dissolving pulp from *Trema orientalis* (Nalita). Water prehydrolysis kraft and soda-ethylenediamine (EDA) pulping for the production of dissolving pulp from *T. orientalis* was investigated. Prehydrolysis at 150 and 170 °C did not produce pulp with high α -cellulose content when using the kraft process. But addition of 0.25 % H₂SO₄ in prehydrolysis liquor increased the purity of the pulp with the sacrifice of pulp yield and viscosity. The soda-EDA process produced better pulp yield, kappa number, viscosity, and α -cellulose content as compared to the kraft process. Increasing EDA charge in the soda liquor increased pulping selectivity and α -cellulose content. Degraded cellulose (R₁₈-R₁₀) in soda-EDA pulp was lower than kraft pulp. But the bleachability of soda-EDA pulp was inferior as compared to kraft pulp in DED bleaching.

Keywords: *Trema orientalis*; Prehydrolysis; Ethylenediamine; α -cellulose; Viscosity

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INTRODUCTION

Most chemical cellulose or dissolving pulp comes from wood using the prehydrolysis kraft or acid sulfite processes (Biermann 1993; Hinck et al. 1985). Dissolving wood pulp is a chemically refined bleached pulp composed of more than 90 percent pure cellulose. The end uses of dissolving pulp include cellophane and rayon, cellulose esters (acetates, nitrates, etc.), cellulose ethers (carboxymethyl cellulose, etc.), graft and cross-linked cellulose derivatives (Sjöström, 1981).

When producing dissolving pulp for making products such as carboxymethyl cellulose, viscose, cellulose film, and sausage skin, determining the pulp quality is essential. The dissolving pulp quality depends both on properties of the raw wood material and the pulp processing. The reactivity of cellulose pulp can refer to its capacity to participate in diverse chemical reactions. The two secondary hydroxyl groups on carbons two and three are more reactive than the primary hydroxyl group on carbon six (Krässig 1993). For derivatization reactions it is important to note that reactions with the hydroxyl groups on carbons two and three are kinetically favorable, while substitution on carbon six is thermodynamically more stable (Schlotter 1988; Krässig 1993). Both celluloses I and II have been found in pulp. Cellulose II is more thermodynamically stable than cellulose I, this may make the dissolving pulps with large proportions of cellulose II more resistant to heating than pulps with large proportions of cellulose I (Lennholm and Iversen 1995; Lennholm and

Iversen 1995a). Dissolving pulp should have special properties, such as a high level of brightness and uniform molecular-weight distribution.

In recent years various innovative pulping methods have been developed, primarily in response to environmental considerations (Vila et al. 2004; Kirci and Akgul 2002). It has been reported in our earlier study (Jahan and Farouqui 2000) that ethylenediamine (EDA) in soda liquor increased delignification and hemicellulose dissolution of jute. So EDA in soda liquor can produce high α -cellulose-containing dissolving pulp.

The two major sources for its production are cotton linters and wood pulp, with the latter being the more important. But forestland in Bangladesh is only 10.2 % (FAO 2005), and population density of our country is very high. Therefore, forestland for industry is decreasing in competition with other land uses. So, it is hard to supply pulpwood from our forest to maintain the growth of the pulp industry. To achieve this, plantation of fast growing species must be established to compensate for the dwindling supply from natural forest. Fast wood plantation can produce one and a half to two times more wood per hectare per year, and reach maturity two to three times faster than longer-rotation softwood plantations (Cossalter and Smith 2003). Higher yield lowers the cost of raw material and less land is needed to produce the same amount of wood. So we can say that restricted access to the natural forest promotes short-rotation wood as sources of fibers.

Acacias and *Eucalyptus camaldulensis* are the most promising fast growing woods in the environment of Bangladesh. Recent literature (Jahan and Mun 2003) showed that *Trema orientalis* is one of the fastest growing trees. The local name of *T. orientalis* in Bangladesh is Nalita. It is also a nitrogen-fixing tree. The environment of Bangladesh favors its good growth. The average height and DBH of Nalita are 11.6 m and 21.3 cm at the age of 24 months (Jahan and Mun 2003). Nalita may be a suitable source of fiber for pulp production in the near future (Jahan and Mun 2004; Jahan et al 2007). Chemical compositions of Nalita wood were 20-24% lignin, 22-23 % pentosan, and 48-50% α -cellulose, along with extractive, ash etc. (Jahan and Mun 2004).

Worldwide, most of the dissolving pulp is produced from softwood fiber, using either the acid-sulfite or prehydrolysis kraft process (Durbak 1993). In the United States and Canada, more than half of the production is from the softwood sulfite process. Japan, South Africa, and Spain are using eucalyptus and other hardwood fiber for dissolving pulp. In Bangladesh, Muli bamboo (*Melocanna baccifera*) has been the main fibrous raw material for manufacturing rayon grade pulp. However, the one rayon mill in Bangladesh has been shut down due to the scarcity of bamboo. So, investigation of *T. orientalis* as an alternative source in producing dissolving pulp may create a new horizon for the pulping sector of Bangladesh.

In this investigation an effort has been made to produce dissolving pulp from *Trema orientalis* (Nalita) by prehydrolysis (PH)-kraft process with varying PH temperature and active alkali charge during cooking. Dissolving pulp was also produced from *T. orientalis* (Nalita) by the soda-EDA process with varying prehydrolysis temperature and EDA charge in the cooking liquor. Produced pulps were bleached by DED bleaching sequences.

MATERIALS AND METHODS

Raw Materials

Nalita (*Trema orientalis*) was collected from Savar, Dhaka. It was chipped to 0.5/1/1 cm size. The moisture content of raw materials was determined according to the TAPPI Standard Method (T 18m-53). After determination of the moisture content of air-dried raw materials, an amount equivalent to 250 gm o.d. (oven dried) was weighed separately in a polyethylene bag for subsequent experiments.

Prehydrolysis

The prehydrolysis was carried out in an electrically heated stainless steel digester of 5 l capacity, rotating at 1 rpm. Water prehydrolysis was carried out either with or without the addition of sulfuric acid at 150 and 170 °C. The wood to liquor ratio was 1: 5. The time required to raise max temperature was 60 min. The liquor was drained after prehydrolysis. The prehydrolysate contains a high amount of sugars. It may be a valuable source of ethanol or other valuable chemicals (Rath et al. 2005). Such opportunities will be studied in our next projects.

Cooking

All pulping experiments were performed in the same digester. The following cooking conditions were maintained in the soda process:

- Active alkali charges were 14, 16, and 18 % on o.d wood
- Sulphidity 25 %
- Liquor to fiber ratio was 4:1 (v/w).
- Temperature was 170 °C.
- Cooking time was 120 min.

Two sets of experiments were carried out in the soda-EDA process, one with prehydrolysis (PH) at 150 and 170 °C, and the other without prehydrolysis. The prehydrolysed wood was subjected to soda-EDA pulping. The proportions of EDA in soda liquor were 10, 20, 30, and 40 % (v/w), respectively. Alkali charge was kept constant at 18 % as NaOH. All other parameters were constant. After digestion the pulp was washed until free from residual chemicals and screened with a flat vibratory screener (Yasuda, Japan). The pulp yield and screened reject were determined gravimetrically as percentages of oven-dry raw materials.

Bleaching

Pulps were bleached in DoED₁ bleaching sequences. The bleaching was done in polyethylene bags. The kappa factor 0.22 was used in the Do stage. The pH of bleach liquor was 2-2.5 in D₀. The bleaching continued to 60 min. at 70 °C. Alkaline extraction was carried out with 2 % NaOH, at 70 °C for 60 min. The consistency was 5 and 10 in the chlorine dioxide and extraction stages, respectively. In final stage (D₁), half of the ClO₂ applied in the Do stage was used. The temperature was 70 °C for 120 min.

Evaluation of Pulps

Pulp tests were performed according to the Standard Methods of the Technical Association of the Pulp and Paper Industry (TAPPI, Atlanta, GA): kappa number (T 236 cm-85); brightness (T 452 om-92); viscosity (T 230 om-89); carbohydrate (T 249 cm00); α -cellulose (T 203 om-88); alkali solubility R_{10} and R_{18} (T 235 cm-85); and ash content (T 211 om 93). Alpha-cellulose is the pulp fraction resistant to a treatment in an aqueous solution containing 17.5% sodium hydroxide and indicates undegraded, high molecular weight cellulose content in pulp. Alkali solubilities R_{10} and R_{18} provide information the low molecular weight carbohydrates (degraded cellulose and hemicellulose) in pulp. A 10% sodium hydroxide solution dissolves both degraded cellulose and hemicellulose (R_{10}) whereas hemicellulose is soluble in an 18% sodium hydroxide solution (R_{18}). All pulp properties were analyzed in duplicate.

RESULTS AND DISCUSSION

To get high purity dissolving pulp, wood chips were prehydrolysed at 150 and 170 °C with and without H_2SO_4 , followed by either the kraft or soda-ethylenediamine (EDA) process, and results are shown Tables 1 and 2. The primary objective of prehydrolysis was to efficiently remove the hemicellulose polymers from the wood by means of water or dilute mineral acid hydrolysis.

Prehydrolysis Kraft Pulping

After prehydrolysis, wood chips were kraft pulped by varying active alkali and results are given in Table 1. A good purity of pulp was not obtained by prehydrolysis at 150 °C. With increasing prehydrolysis temperature to 170 °C, purity of pulp was increased to 86-90 % from 81-86 % depending on active alkali charge during kraft cooking. The sulfuric acid had a strong effect on the severity of hydrolysis. The yield loss in prehydrolysis with 0.25 % H_2SO_4 was 2.7-4.2 % depending on active alkali during cooking (Table 1). But α -cellulose content in pulp was increased to 91.0 % from 89.8 % at 18 % active alkali in cooking. Apparently, only a part of the hemicellulose was dissolved in the PH stage, which is indicated by R_{18} value (Table 1). The results presented in Table 1 show that prehydrolysed at 150 °C did not produce pulp of kappa number below 20. Drastic PH treatment improved delignification considerably. Other report showed that kappa number increased with the severity of PH due to enhanced condensation reaction (Kordsachia et al. 2004). But pulping selectivity was considerably decreased when H_2SO_4 was added in the PH (Fig. 1).

In the case of PH at 150 °C the screened pulp yield was increased and reject decreased with the increase of active alkali charge. Maximum screened pulp yield was observed at 16 % active alkali in the case of PH at 170 °C with and without H_2SO_4 , where kappa number was 18.8 and 22.3, respectively. Addition of H_2SO_4 in PH liquor or increasing PH temperature impaired the pulp viscosity considerably (Table 1). The viscosity was reduced to 13.0 from 15.1 with the addition of 0.25 % H_2SO_4 in PH liquor

and to 15.1 from 16.9 with the increase of PH temperature from 150 to 170 °C at 18 active alkali charges.

Table 1. Effect of Prehydrolysis and Alkali in Kraft Cooking on the Dissolving Pulp from *Trema orientalis*

Prehydrolysis	Alkali, %	SY	R	TY	KN	α -cellulose	Viscosity mPa.s	R-18	R-10	B
150 °C, 1h	14	40.1	6.8	46.9	46.0	81.0	22.6	86.1	82.3	27.7
	16	45.0	0.9	45.9	35.2	83.0	19.8	86.7	83.2	28.5
	18	44.4	0.3	44.7	21.0	85.5	16.9	86.9	82.9	29.4
170 °C, 1h	14	41.4	3.6	45.0	32.1	85.8	20.2	87.2	83.3	30.4
	16	44.3	0.2	44.5	22.3	87.5	18.8	88.6	83.4	31.3
	18	44.0	0	44.0	18.9	89.8	15.1	90.3	82.1	31.9
170 °C, 1h 0.25 % H ₂ SO ₄	14	40.4	1.9	42.3	19.7	88.5	16.2	90.0	84.5	35.3
	16	40.7	0.2	40.9	18.8	89.9	15.3	91.2	85.0	35.7
	18	39.8	0	39.8	17.0	91.0	13.0	92.7	84.8	35.9

SY- Screened yield, R-Reject, TY-Total yield, KN-Kappa number, B- Brightness

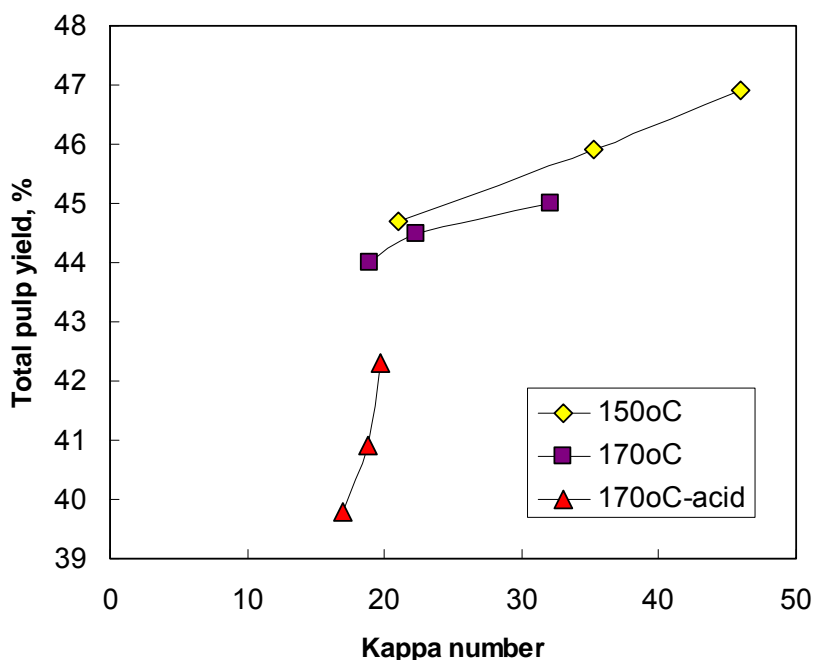


Fig. 1. Effect of prehydrolysis on the selectivity of pulping in kraft process

Soda-ethylenediamine (EDA) and Prehydrolysis Soda-EDA Pulping

As in PH- kraft cooking, the wood chips were prehydrolysed at 150 and 170 °C. Except for the EDA charge, all cooking parameters were kept constant. The active alkali was 18 % as NaOH on o.d. wood. The cooking was continued to 120 min at 170 °C. Pulping selectivity was improved with the increase of EDA. Reject decreased with an addition of EDA in the cooking liquor. A higher α -cellulose in pulp was obtained when

cooking with higher EDA charge (Table 2). Considering screened pulp yield, kappa number, and α -cellulose content, PH at 170 °C showed better selectivity compared to EDA addition at 150 °C. The temperature of prehydrolysis also was found to have some significant effect on final α -cellulose content of the pulp (Day et al., 2007). The high yield combined with high alpha-cellulose content has to be attributed to high cellulose yield, high viscosity, and possibly the preservation of a high amount of high-molecular weight xylan. The α -cellulose content in pulp was increased with increasing EDA in soda liquor.

Table 2. Effect of Prehydrolysis and EDA Concentration in Soda-EDA Cooking on the Dissolving Pulp from *Trema orientalis*

Prehydrolysis	EDA %	SY	R	TY	KN	α -cellulose	Viscosity mPa.s	R-18	R-10	B
Without prehydrolysis	10	46.0	1.3	47.3	28.8	82.1	22.4	84.5	83.3	20.2
	20	47.2	1.0	48.2	27.2	83.6	23.0	86.0	85.2	20.3
	30	48.6	0	48.6	26.0	86.5	23.7	88.1	86.1	20.2
	40	48.0	0	48.0	25.1	87.2	23.9	89.2	87.3	22.2
150 °C, 1h	10	42.9	3.3	46.2	25.6	83.0	20.3	87.2	85.8	20.1
	20	44.8	0.5	45.3	23.6	84.9	19.4	88.5	86.2	23.2
	30	45.0	0	45.0	22.1	87.6	19.5	88.9	87.1	23.0
	40	45.1	0	45.1	18.2	89.8	19.8	90.1	88.8	22.4
170 °C, 1h	10	44.0	0.5	44.5	21.7	86.8	18.2	88.1	86.0	23.0
	20	44.8	0.1	44.9	22.0	88.5	18.5	89.7	88.4	23.6
	30	44.9	0	44.9	19.8	89.0	19.1	90.8	88.9	23.6
	40	44.3	0	44.3	17.3	90.2	19.5	92.2	90.0	24.1

Compared to the PH- kraft pulp, the R_{10} values were higher in PH-soda-EDA and soda-EDA pulps, and the difference between R_{18} and R_{10} was lower, which indicated that EDA pulp contained less degraded cellulose. EDA in soda liquor protects α -cellulose from alkaline peeling and degradation (Kubes and Bolker 1978; Kubes et al 1978).

Prehydrolysis at 170 °C followed by soda-EDA pulping produced better pulp yield and kappa number than the corresponding PH (170 °C)-kraft process (Fig. 2). Soda-EDA process showed much improved pulp yield and α -cellulose content when EDA charge in cooking liquor was high. At 40 % EDA charge, α -cellulose content was 87.2 % (Table 2). Pulp viscosity can be improved to some extent in the soda-EDA process. Even soda-EDA pulp with PH at 170 °C showed higher viscosity than the kraft pulp with PH at 150 °C. Pulp viscosity and α -cellulose content increased with the increase of EDA in the cooking liquor. MacLeod et al. (1984) also observed that the soda-EDA process dissolved the greatest amount of xylan from spruce. Best pulp properties, especially with regard to the kappa number to viscosity ratio and high α -cellulose content, were obtained with PH at 170 °C followed by soda-EDA pulping. Julien and Sun (1979) also observed better delignification when EDA was added in soda liquor. The presence of amine in soda liquor altered the molecular weights of the dissolved lignin fraction, and delignification is also associated with the negative reduction potential of pulping additive (Chuiko et al. 1973). At 90 % α -cellulose content, PH-soda-EDA pulp showed about 4 mPa.s higher viscosity (Fig. 3). Pulp brightness in soda-EDA process was lower in comparison to the kraft process (Tables 1 and 2).

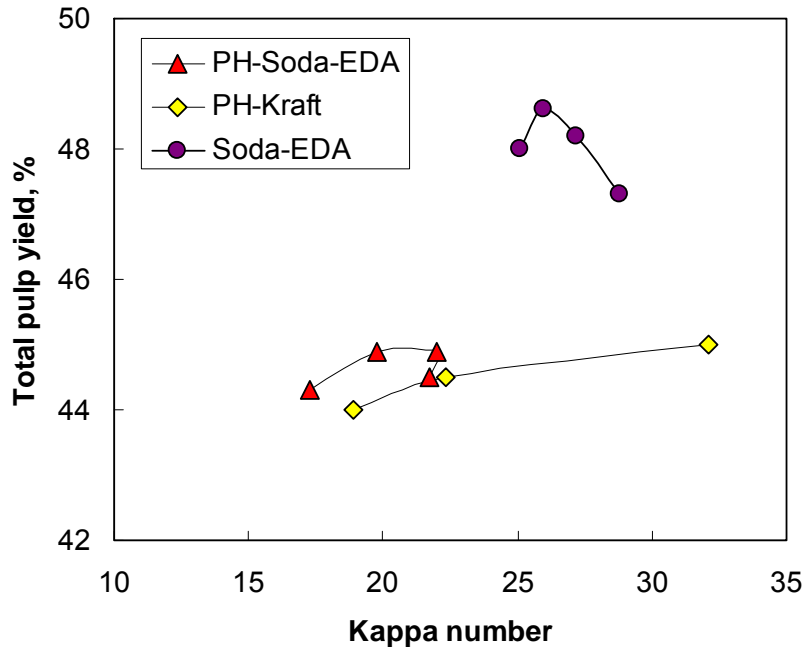


Fig. 2. Effect of pulping process on the selectivity (PH at 170°C)

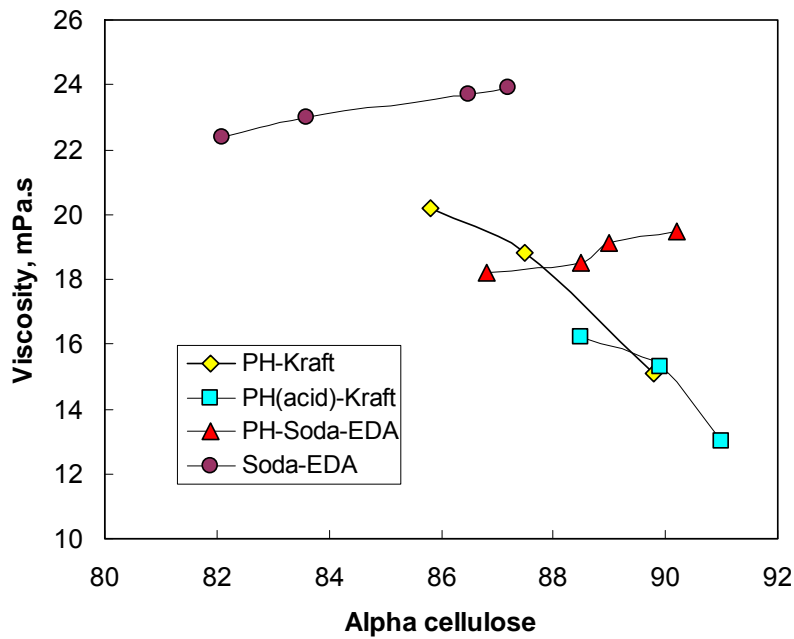


Fig. 3. Alpha-cellulose viscosity relationship of different pulping processes

Bleaching

Bleaching of dissolving pulp is primarily a purification process. All produced pulps were bleached by DED bleaching sequences under identical conditions. Bleaching improved the α -cellulose content in pulp with the sacrifice of viscosity (Tables 3 and 4). The purity of bleached pulp was dependent on the severity of prehydrolysis and active alkali in cooking. The α -cellulose contents were increased to 90-93 % from 85-89 % with the increase in PH severity (from 150 °C to 170 °C and 0.25% H₂SO₄). This was also cross-checked by R₁₈ values. R₁₈ values were increased with the severity of PH. Degraded cellulose percentage was also increased with the increase of severity, as indicated by R₁₈-R₁₀. In this period viscosity was dropping to 8-9 mPa.s from 12-13 mPa.s, depending on alkali charge in cooking. As expected, the pulp brightness was also increased with the increase of active alkali charge in cooking. It was found in our earlier study that the bleachability increased markedly with increasing active alkali charge and sulphidity (Jahan et al. 2008). With the increase of prehydrolysis severity pulp brightness was increased. This indicates that *T. orientalis* lignin was not condensed under severe prehydrolysis conditions. A maximum brightness of the pulp of 84.1 % was attained by prehydrolysis at 170 °C with 0.25 % H₂SO₄ and 18 % active alkali.

Table 3. ECF Bleaching of Prehydrolysis Kraft Pulp Obtained under Different Conditions

Prehydrolysis	Alkali, %	α -cellulose	Viscosity mPa.s	R-18	R-10	Carboxyl group	B
150 °C, 1h	14	85.3	13.2	86.9	84.8	3.6	79.8
	16	87.2	12.1	89.5	86.7	3.5	80.5
	18	88.8	11.7	90.2	87.0	3.2	81.6
170 °C, 1h	14	88.2	11.8	90.0	87.6	3.2	80.9
	16	89.3	10.4	92.3	89.3	3.1	81.6
	18	90.8	10.0	92.9	89.7	2.8	81.8
170 °C, 1h 0.25 % H ₂ SO ₄	14	90.4	9.4	92.3	89.3	3.0	82.3
	16	91.5	9.0	93.7	90.1	3.0	83.2
	18	92.9	8.2	94.3	90.5	3.1	84.1

Table 4. ECF Bleaching of Soda-EDA Pulp Obtained under Different Conditions

Prehydrolysis	EDA %	α -cellulose	Viscosity mPa.s	R-18	R-10	Carboxyl group	B
Without prehydrolysis	10	87.1	15.4	89.1	87.2	3.3	77.3
	20	87.3	15.8	89.2	87.4	3.3	77.4
	30	87.9	16.3	89.9	88.7	3.1	77.7
	40	88.2	16.2	90.2	89.0	3.0	77.5
150 °C, 1h	10	87.7	12.3	88.9	86.5	3.1	78.1
	20	87.9	12.4	89.3	87.4	2.9	78.7
	30	88.9	12.7	91.0	88.8	2.6	78.9
	40	89.8	12.9	91.5	89.6	2.5	77.9
170 °C, 1h	10	89.1	11.1	91.3	89.4	2.6	79.3
	20	90.7	11.3	92.6	90.5	2.4	79.6
	30	92.2	11.7	94.5	92.5	2.2	79.8
	40	93.2	11.7	95.2	93.3	2.1	79.6

Soda-EDA pulp was less bleachable in comparison to kraft pulp, as shown in Table 4. Brightness was independent of EDA charge in the cooking liquor. But the brightness was slightly improved with the increase of prehydrolysis temperature (from 78 to 79-80 %). The α -cellulose contents were increased with the increase of EDA in the cooking liquor. Also a marginal increase in viscosity was observed with increasing EDA charge. This was explained by higher viscosity in the unbleached state. R_{18} values were increased with the increase of EDA charge in the cooking liquor. R_{18} - R_{10} values were decreased with increasing EDA charge, which indicated that it selectively removed pentosans from the pulp.

The carboxyl group content was 3.0-3.6 meq/100 g pulp in the kraft process and 2.1-3.3 meq/ 100 g pulp for the soda-EDA process, depending on conditions. The lower value of carboxyl group content in soda-EDA pulp indicates that there was no oxidation in the pulp. Prehydrolysis temperature and active alkali in the kraft process reduced the carboxyl group content in the pulp, which is correlated with α -cellulose content R_{10} and R_{18} values. PH with H_2SO_4 increased the carboxyl group content in pulp, which indicates oxidation of the pulp. The carboxyl group content in soda-EDA pulp decreased with the increase of EDA in soda liquor, which is associated with removal of hemicellulose and protection of cellulose oxidation.

Comparison of Different Alkaline Dissolving Pulp

A comparison of properties of different dissolving pulps obtained after final bleaching is shown in Fig. 4. Addition of acid in prehydrolysis increased α -cellulose content 2.1 % and the brightness by 2.3, but it decreased viscosity of the kraft pulp by 1.8 mPa.s. Soda-EDA had a much higher viscosity than kraft pulp. Without prehydrolysis the soda-EDA process produced pulp of 88.2% α -cellulose content with 16.2 mPa.s viscosity. But prehydrolysis at 170 °C increased α -cellulose content to 95.2%, which was the highest among all the processes considered. The viscosity of PH-soda-EDA pulp was higher than PH- kraft pulp (Fig. 4).

Helmy and State (1991) observed higher pulp yield, higher α -cellulose content, higher degree of polymerization, and lower pentosan of bagasse pulp when EDA was added in soda liquor. The increase in viscosity and the substantial increase in alpha-cellulose could also be attributed to the selective removal of hemicelluloses, e.g. xylan, which is rather more likely than a mechanism involving “stabilization” of the alpha-cellulose as indicated by Kubes and Bolker (Kubes and Bolker 1978; Kubes et al 1978). A slightly decreasing trend of pentosan in pulp was observed with increasing EDA addition by Jahan and Farouqui (2000). Final brightness of soda-EDA pulp was lower than kraft pulp. PH soda-EDA pulp showed a little bit better brightness than that of soda-EDA pulp. Lower bleachability of soda-EDA pulp is under investigation in our laboratory.

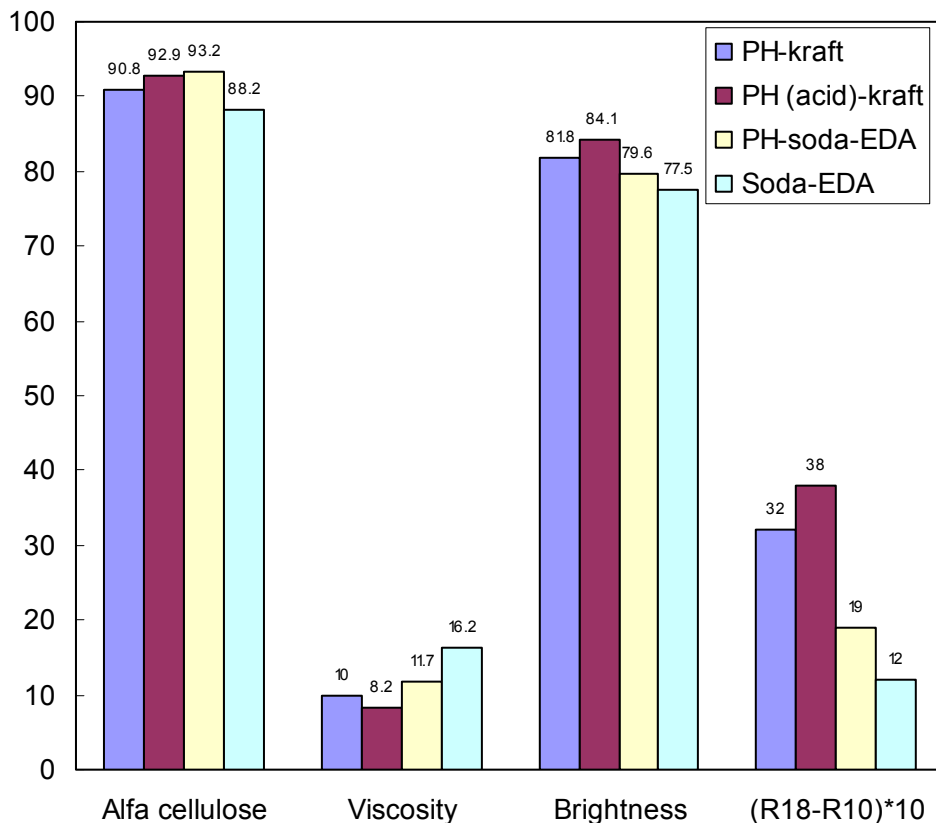


Fig. 4. Comparison of pulp properties of different processes

$R_{18}-R_{10}$ values indicate the content of degraded cellulose having a degree of polymerization between approximately 50 and 150 (Hinck et al. 1985). Soda-EDA pulp showed better $R_{18}-R_{10}$ value. These results are consistent with the data of α -cellulose and viscosity. The main problem of soda-EDA process was bleachability. Unbleached brightness of soda-EDA pulp was lower, which indicates its lower bleachability.

The hemicellulose composition of the dissolving pulps from the different processes differed as well (Table 5). The superiority of PH-soda-EDA pulp is evident. In this process 93 % (based on raw material) of the xylan was removed. Soda-EDA process without PH also removed more xylan than PH-kraft process. This indicates that the EDA in soda liquor selectively removes hemicellulose. Ash content in these pulps was 0.08-0.15 %. Residual pentosan and ash in a dissolving pulp are considered contaminants for the preparation of cellulose derivatives, but these values were below the recommended limits (Hinck et al 1985; Sixta and Borgards 1999). Again the PH-soda-EDA process showed better results in residual ash content. The beneficial role of prehydrolysis was also demonstrated in the ash content (Table 5). Rosli et al (2003) also observed that prehydrolysis removed ash and hemicellulose from oil palm fiber. Addition of acid in PH reduced the ash content from 0.15% to 0.12 % in the kraft process. But the ash content in soda-EDA pulp without PH was lower than the PH(acid)-kraft pulp. This also shows that EDA in soda liquor removes mineral.

Table 5. Hemicellulose Composition of the Dissolving Pulp.

Sample	Neutral sugars					Ash
	Rhamnose	Arabinose	Xylose	Mannose	Galactose	
PH-Kraft	0.11	0.22	10.1	0.21	0.23	0.15
PH(acid)-Kraft	0.08	0.14	6.1	0.22	0.21	0.12
Soda-EDA	0.54	0.33	8.3	0.29	0.31	0.11
PH-Soda-EDA	0.08	0.11	3.5	0.28	0.38	0.08

CONCLUSIONS

Increasing prehydrolysis temperature and active alkali charge in cooking liquor improved degree of delignification, bleachability, and α -cellulose content of kraft pulp. Addition of H_2SO_4 in PH liquor increased α -cellulose content with the sacrifice of viscosity. But the degraded cellulose (R_{18} - R_{10}) in pulp was also increased. Improved pulp yield and degree of delignification was observed when pulping was carried out with a soda-EDA process. The α -cellulose content was increased with increasing EDA charge in soda liquor. The viscosity and degraded cellulose (R_{18} - R_{10}) of soda-EDA pulp was better than kraft pulp. The bleachability of soda-EDA pulp was lower than kraft pulp. EDA selectively removed lignin and hemicellulose and protected α -cellulose. So EDA in soda liquor may be useful in producing dissolving pulp.

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