EFFECT OF ANTHRAQUINONE IN KRAFT AND SODA PULPING OF BAGASSE

P. Das
S. K. Bose
A. F. M. Akhtaruzzaman

ABSTRACT

The effect of anthraquinone (AQ) addition in kraft and soda pulping of bagasse has been studied in the laboratory. The results show that AQ addition by 0.05% in soda pulping increases the pulp yield by 2.5 per cent units compared to normal soda pulping. The yield increases by 4.5 per cent units by using 0.15% AQ. In kraft -AQ pulping, the gain in yield is less remarkable. The quality of the pulp improves by addition of AQ both in soda and kraft pulping.

সারসংক্ষেপ

এই সমীক্ষায় ক্র্যাফট ও সোডা প্রক্রিয়ায় আঁখের ছোবড়ার মণ্ডীকরণে এনথ্রাকুইননের প্রভাব নিরীক্ষিত হয়েছে। গবেষণালব্ধ ফলাফল থেকে দেখা যায় যে, সোডা প্রক্রিয়ায় ০·০৫% এনথ্রাকুইনন ব্যবহার করলে ২·৫ শতক একক অধিক মণ্ডোৎপাদন সম্ভব। যদি এনথ্রাকুইনন ব্যবহার ০·১৫% এ উন্নীত করা হয় তবে ৪·৫ শতক একক অধিক মণ্ড উৎপাদিত হয়। ক্র্যাফট পদ্ধতিতে আঁখের ছোবড়া মণ্ডীকরণে এনথ্রাকুইনন প্রভাব সোডা পদ্ধতির তুলনায় কম। এনথ্রাকুইনন ব্যবহারে ক্র্যাফট ও সোডা পদ্ধতিতে প্রাপ্ত মণ্ডের গুণগত মান উন্নত হয়।

INTRODUCTION

It is well known that sulphide markedly promotes the alkaline digestion in making pulp. More severe conditions, e. g., longer cooking time and higher alkali charge are required during soda cooking to obtain a pulp of a desired kappa number. Bagasse, like other agricultural residues, has a very open structure and is very reactive. As a result, the protective action of sulphide in kraft pulping has very little effect in pulping of bagasse (Hurter 1988). Consequently, soda pulping is a common process for production of bagasse pulp (Granfeldt et al 1988).

The discovery of the effect of anthraquinone (AQ) on alkaline pulping has made it possible to develop novel pulping modifications. A small addition of AQ in kraft and soda cooking enhances the rate of delignification with improved yield. AQ addition in the order of 0.05-0.15% on oven-dry fibrous raw material is sufficient to provide the benefits (Fossum et al. 1980; Holton 1977; Holton and Chapman 1977). The catalytic effect of AQ is more effective in soda pulping than in kraft pulping (Fossum et al. 1980; Kubes et al. 1980). More economic benefits are obtained with hardwoods than with softwoods (Fossum et al. 1980; Hanson and Michaeles 1978).

P. Das, Research Assistant; S. K. Bose, Junior Research Officer, and A. F. M. Akhtaruzzaman, Divisional Officer, Pulp & Paper Division, Bangladesh Forest Research Institute, Chittagong.

Though the effect of AQ on pulping of wood is well documented, very little work has been done on bagasse. A study by MacLeod et al. (1979) shows that only one soda-AQ cook has been made with bagasse. The results are encouraging in bagasse pulping too. However, concrete conclusions cannot be made with the limited data. Thus, a more elaborate study on the effect of AQ in kraft and soda pulping of bagasse is warranted. The study is particularly important for the North Bengal Paper Mills which produce soda pulp from bagasse.

MATERIALS AND METHODS

Depithed bagasse was obtained from the North Bengal Paper Mills. It was a one year old stock and was partially decomposed due to storage. Bagasse was air-dried and sampled for cooking.

Pulping was done in a 23 *l* rotating digester using indirect steam. The digester was initially heated to a temperature of 80°C and then air-dried bagasse equivalent 1.5 kg oven-dried sample was charged with chemicals in all the cooks. The effect of AQ on kraft and soda pulping was studied by using two doses of AQ, viz., 0.05 and 0.15% on oven-dried bagasse. In all the cases the different points of delignification were obtained by varying the cooking time. Other cooking conditions were maintained at 12% active alkali as Na_2O (13% active alkali for normal soda), 25% sulphidity for kraft, 4:1 liquor to bagasse ratio and 60 min. to raise the temperature form 80° to 160°C.

At the end of the digestion, the cooked bagasse was discharged, washed over night under running water, disintegrated and screened on a flat vibratory screen with 0.38 mm slots. The screened pulp was pressed to remove excess water, shredded, weighed and sampled to determine the moisture content. The screening rejects were oven-dried. The pulp yield and screened pulp kappa number were then determined. The pulp was refined in a Velley beater to different freeness values, and handsheets were made for determining the strength properties after conditioning at 23 ± 1°C and 50% ± 1% relative humidity. The pulp strength properties were determined according to SCAN Test Methods.

RESULTS AND DISCUSSION

The results on the effect of AQ in kraft and soda pulping of bagasse are given in Table 1. It is observed from Table 1 and Fig. 1 that the addition of AQ markedly

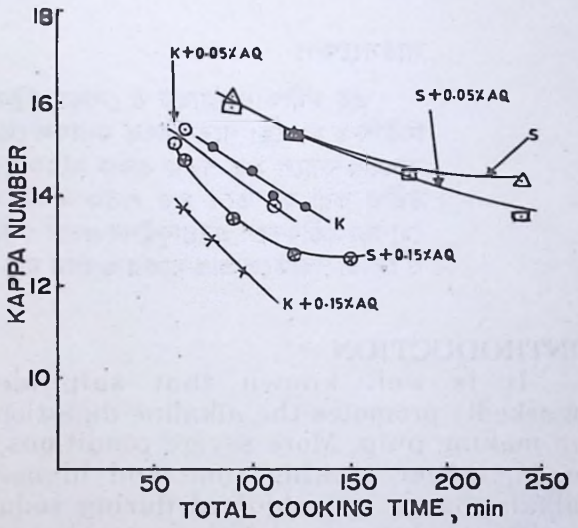

Fig. 1. Delignification during kraft-AQ, kraft, soda-AQ, (12%AA as na_2o, 25% sulphidity for kraft) and soda (13%AA as Na_2o) pulping of bagasse with addition of anthraquinone

reduced the cooking time to reach a particular point of delignification. An addition of 0.05% AQ needed 1% lower alkali in soda pulping. Use of 0.15% AQ in the soda cook curtailed the total cooking time by about 30% and the cooking time at

the maximum temperature by about 65% compared to the kraft counterpart. AQ was also observed to be effective in accelerating the delignification in kraft pulping of bagasse (Fig. 1). But the effect was less remarkable compared to soda pulping.

AQ catalysed pulping resulted in a substantial gain in pulp yield (Fig. 2). The

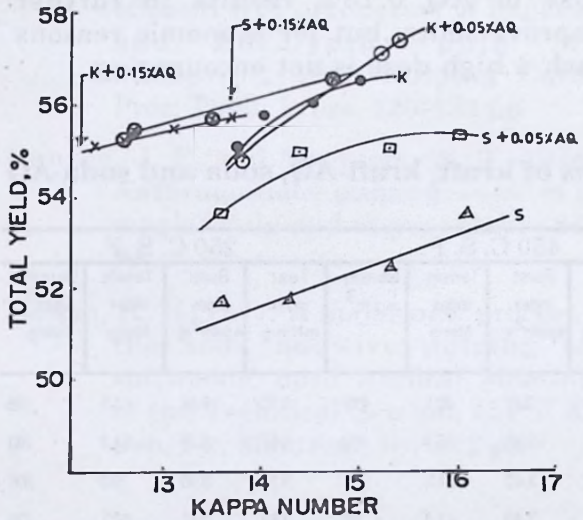

Fig. 2. Total yield as a function of kappa number in kraft-AQ, kraft, soda-AQ and soda pulping of bagasse with addition of anthraquinone

yield gain was particularly remarkable in soda pulping. An addition of 0.05% AQ in soda cooking increased the pulp yield by 2.5 per cent units at a kappa number of 14. The yield was, however, lower by 1.4 per cent units compared to the normal kraft. An addition of 0.15% AQ in soda pulping increased the yield to 56.1% when the soda control produced an yield of 51.6%. This means that, in such a case, the yield gain amounted to 4.5 per cent units. However, the cost of AQ may not probably favour for using 0.15% in soda pulping of bagasse, when an yield increase of 2.5 per cent units is possible with 0.05% AQ addition.

AQ is less effective in preserving the yield in kraft pulping of bagasse (Fig. 2). Rather, the yield remained almost unchanged with an addition 0.05% AQ. Some beneficial effect can, however, be expected with the use of 0.15% AQ. The yield gain in such a case may not balance the cost of AQ.

As regards the physical strength properties, Table 1 shows that burst index, tensile index and tear index at a particular freeness of soda-AQ pulp at a kappa number of about 14 were better compared to the normal soda pulp. The tear index of soda-AQ pulp was even superior to the kraft pulp. The tensile index was slightly inferior to the kraft counterpart with 0.05% AQ addition in the soda cook. The property, however, surpassed the kraft on addition of 0.15% AQ in soda pulping.

The use of AQ in kraft pulping caused the tear index to drop slightly or remain almost unchanged compared to the normal kraft. Kraft-AQ pulp showed improved tensile and bursting strengths.

The change of tearing strength with tensile strength of the pulp during the beating cycle is shown in Fig. 3. The

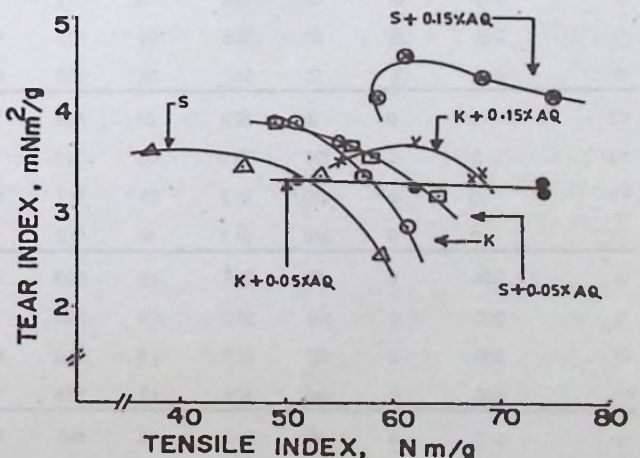

Fig. 3. Tear-tensile plots for pulps at a kappa number of 14±0.5 in kraft-AQ, kraft, soda-AQ and pulping of bagasse with addition of anthraquinone

figure indicates that tear index of the pulp at a certain tensile index improved with AQ addition both in kraft and soda pulping. Soda-AQ pulp resulted in better tear-tensile values than the reference kraft pulp.

Based on the findings (increased pulp yield, a lower alkali requirement, a reduced cooking time and kraft-like or better pulp properties) this investigation shows a good prospect of using AQ in the North Bengal Paper Mills at Paksey. The mill uses bagasse as the fiberous raw material.

CONCLUSIONS

It has been observed that AQ gives positive effects in increasing pulp yield, reducing cooking time and improving the quality of pulp in soda and kraft pulping of bagasse. The effect is more pronounced in soda pulping than in kraft pulping. An addition of AQ by 0.05% seems to be sufficient to bring the benefits. A higher dose of AQ 0.15% results in further improvements; but for economic reasons such a high dose is not encouraging.

Table 1. Cooking conditions and pulp properties of kraft, kraft-AQ, soda and soda-AQ pulps from bagasse

								450 C. S. F.				250 C. S. F.			
Active alkali as Na_2O %	AQ %	Sulphidity %	Total cooking time min	Screened Yield %	Rejects %	Total yield %	Kappa No	Tear Index mNm^2/g	Burst index $Kpam^2/g$	Tensile index Nm/g	Density Kg/m^3	Tear index mNm/g	Burst index $Kpam^2/g$	Tensile index Nm/g	Density Kg/m^3 Nm/g
12	0	25	30	55.9	0.6	56.5	150	4.15	3.27	60.1	715	3.70	3.88	63.5	785
12	0	25	100	55.7	0.3	56.0	14.5	4.06	2.89	55.4	710	3.57	3.72	64.2	780
12	0	25	110	55.0	0.8	55.8	14.0	3.78	3.40	54.5	725	3.15	3.90	59.0	805
12	0	25	127	53.8	1.2	55.0	13.8	3.90	3.40	47.4	710	3.68	3.81	60.2	779
12	0.05	25	60	55.4	1.7	57.1	15.2	4.05	3.65	62.0	750	3.55	4.02	69.0	780
12	0.05	25	65	56.5	0.8	57.3	15.4	3.35	3.40	58.5	702	3.25	4.36	69.0	785
12	0.05	25	110	54.2	0.6	54.8	13.8	3.30	3.67	56.8	720	3.20	4.50	73.8	783
12	0.15	25	65	54.2	1.5	55.7	13.7	3.60	3.70	52.0	680	3.35	4.10	68.0	790
12	0.15	25	80	54.6	0.9	55.5	13.1	3.29	3.62	62.8	704	3.13	4.19	70.4	800
12	0.15	25	95	54.2	0.8	55.0	12.3	3.52	3.61	62.0	710	3.45	4.48	70.5	783
13	0	0	90	52.9	0.7	53.6	16.1	3.58	3.05	51.4	634	2.90	3.68	61.7	790
13	0	0	120	51.0	1.5	52.5	15.3	3.26	2.88	53.3	663	2.94	3.51	59.4	721
13	0	0	180	51.2	0.5	51.7	13.6	3.64	2.86	48.1	705	3.10	3.55	60.9	790
13	0	0	240	51.3	0.5	51.8	14.3	3.50	2.65	42.0	690	2.96	3.30	56.5	770
12	0.05	0	90	53.8	1.5	55.3	16.0	3.61	3.25	50.9	708	3.42	4.08	53.8	770
12	0.05	0	120	53.7	1.3	55.0	15.3	3.24	3.10	55.5	683	3.06	3.93	63.4	770
12	0.05	0	180	53.7	1.2	54.9	14.4	3.78	2.75	50.0	645	3.50	3.45	57.0	720
12	0.05	0	240	52.6	1.0	53.6	13.6	3.50	2.65	42.0	690	2.96	3.30	56.5	770
12	0.15	0	65	54.7	1.8	56.5	14.7	4.37	3.28	59.3	967	4.69	3.81	65.9	1108
12	0.15	0	90	55.7	0	55.7	13.5	4.20	3.35	53.9	710	4.30	3.90	71.7	750
12	0.15	0	120	54.3	1.2	55.5	12.7	4.00	3.10	54.5	703	4.03	3.00	62.7	780
12	0.15	0	150	54.1	1.1	55.2	12.6	4.04	2.65	53.0	695	3.50	3.25	63.3	775

Liquor to bagasse ratio 4 : 1, rise of temperature from 80°C to 160°C by 60 min, cooking temperature 160°C, sulphidity for kraft and kraft-AQ = 25%

REFERENCES

Fossum, G.; Hagglund, S. and Lindqvist, B. 1980. Alkaline pulping of pine and birch with anthraquinone as an additive, part 2, soda pulping. Svensk Papperstiding 83 (16) : 455-460

Granfeldt, T.; Norden, S.; Danielsson, O.; and Ryrberg, K. G. 1988. Towards effluent-free production of bagasse and Eucalyptus pulp for newsprint. 1988 Pulping Conf. Proc. Tappi Press. 129-134 pp

Hanson, J. P. and Michaels, W. T. 1978. Anthraquinone pulping -------- is it magic? Pulp and Paper (May) : 86-90

Holton, H. H. 1977. A major new process : the soda additive pulping of softwoods. 63rd Annual Meeting of the Technical Section, C.P.P.A. Feb. 1-2, Montreal. 107-112 pp

Holton, H. H. and Champman, F. L. 1977. Kraft pulping with anthraquinone. Tappi, 60(11) : 121-125

Hurter, A. M. 1988. Utilization of annual plants and agricultural residues for the production of pulp and paper. 1988 Pulping Conf. Proc., Tappi Press. 139-160 pp

Kubes, G. J.; Fleming, B. I.; MacLeod, J. M. and Bolker, H. I. 1980. Alkaline pulping with additives. A review. Wood Science and Technology, 14(3) : Le 207-228

Macleod, J. M.; Fleming, B. I.; Kubes, G. J. and Bolker, H. I. 1979. The strengths of kraft-AQ and soda-AQ pulps. Part 1-Bleachable grade pulps. 1979 pulping Conf. Proc. Tappi Press. 199-204 pp