Athraquinone Catalysed Kraft Pulping of Leucaena Leucocephala

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SUMMARY

With a view to study the economy of pulping *Leucaena Leucocephala* wood using anthraquinone, laboratory studies were carried out to confirm the benefits of AQ addition in Kraft pulping liquor, by using 0.05% AQ and varying the active alkali charge and H—factor. It has been found that a possible, reduction of 1.9% in active alkali with 1.8% gain in pulp yield could be achieved by using 0.05% AQ without any adverse effect on the pulp bleachability and other properties. Similarly, H—factor could be brought down from 1457 to 960 which simultaneous pulp yield gain of 1.4% by using 0.05% AQ.

To improve upon the soda process, which suffers from low pulp yield and inferior quality caused by excessively long cooking times, higher temperature and caustic charges necessary to produce bleachable grade pulps, an additive was developed by Back and Fichn[1]. They reported that by addition of small quantity of of anthraquinone monosulfonate (AMS) to soda and kraft cooks of pine, pulp was increased without any adverse effect on strength AMS was found to stabilize polysaccharides towards alkaline degradation and to interact with lignin causing its rapid and extensive removal. However, AMS cost-benefit relationship constituted a barrier to its commercialization.

Recently Holton[2,3] found that anthraquinone (AQ) and its derivatives with alkyl substituents (e g. 2 methyl—AQ) are superior additives than its sulphonate derivative AMS Holton has called AQ as a "Miracle" cure-all additive in improving conventionnl kraft pulping[4].

A flurry of trials in kraft and soda mills all over the world[5,6] have been carried out after Holton's announcement in 1977. In India also, few efforts have been made to study the effects of AQ in pulping softwoods, mixed hardwood and bamboo[7,8].

Use of AQ in pulping has been found to have a marked catelytic effect. In addition to enhancing the rate of delignification, AQ is said to stabilize carbohydrates [9,10] and at comparable permagnate numbers, unbleached pulp yields were always found to be higher for kraft AQ or Soda—AQ pulps, with no seemingly adverse effect on bleachability, beating characteristics and stength properties of bleached and unbleached pulps[6,11,12].

MECHANISM OF AQ PULPING :

It is known that addition of AQ during alkaline cooking leads to oxidation of reducing sugars and groups in the wood during the early stages of the cook[13,14]. This reaction stabilizes the carbohydrates against endwise degradation and leads to the formation of Anthrahydroquinone which is then reoxidised to AQ by reacting with lignin at 100°C. This stabilization of carbohydrates leads to higher yields as well as increased delignification. Thus AQ acts as an organic catalyst in the process Increased delignification in kraft AQ pulp could be also due to the the more pronounced cleavage of Barylether linkage in phenolic units[15,16] of wood lignin Though the hydrosulphide ion also causes cleavage of Baryl and ether linkage in Phenolic units but it seems that small amount of AQ enhances cleavage thereby giving more delignified pulp.

With a view to optimize pulping operations,

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sulphate chemical pulping for *Leucaena leucocephala* has been studied in details in the present communication. Cooking trials with AQ catalyzed sulphate chemical cooking have also been investigated to find out the economy of AQ addition in sulphate pulping liquor.

Following approaches of immediate interest have been made in the present work to study how far AQ would be useful in reducing the cost of pulp manufacturing :—

(i) Active alkali reduction with a simultaneous yield gain.

(ii) H-factor reduction with a simultaneous yield gain while increasing capacity.

(iii) Reduction in bleach chemical reduction with practically no yield disadvantage.

EXPERIMENTAL

The exeriments were designed for stepwise reduction in active alkali charge or H-factor (time at temperature) to find the alkali charge and time requirement for the same extent of delignification (K. No.) when AQ is used in coocking liquor compared to a control kraft cook.

Leucaena leucocephala (Hawaiian Giant K–8 variety) wood logs of four to six years age old trees were obtained from Bharatiya Agro Industries Foundation. Urlikanchan Dist. Pune for the present study. The bark was removed manually and chips were prepared in papco chippers of Nepamills. The chips were screened and the chips passing through 20 mm diameter holes and those retained on 5 mm diameter holes were collected for studies. AQ kraft pulping was conducted in the same manner as for a typical kraft cook except that the AQ dosing of 0.05% on chip basis was done in the beginning of cook.

Following cooking conditions were maintained :—

Dilution ratio	— 1 : 3 5
Alkali charge	— varying
AQ for AQ kraft pulps	— 0.05%
Sulphidity of white liquor	— 18%

Cooking Schedule

Raising time to 100°C	— 0.5 hr.
From 100°C to 165°C	— 1.5 hr.
Cooking time at165°C	— Varying time

Permanganate number, yield and rejects were determined by conventional TAPPI standard methods. The results are tabulated in Table 1.

RESULTS AND DISCUSSION

APPROACH I

Active Alkali reduction with simultaneous yield gain:

With 14% Active Alkali (AA) and 1457 H—factor *Leucaena leucocephala* was Cooked to 20 5 permanganate number with 52 7% yield (control cook I). Under the same conditions, permanganate number was found to be reduced by 3.5 units with 0 05% AQ (cook No. 2). AA charge was then reduced in steps of 1% from 14% to 12% maintaining the same H—factor (Table I). It was observed that permanganate number gradually increased from 17 0 to 20 9. On Fig. 1 by drawing a horizontal line at control cook permanganate number of 20.5, it was found that the line intersects the curve at 12 1 AA charge indicating a possible reduction of 1.9 in AA or 10 Kg. AA/Ton *Leucacna leucocephala* using 0 5 kg. of AQ/Ton for maintaining permanganate number at same level.

Also at 12.1% AA and 0.05% AQ, the yield was more by 1.8% as compared to control cook No. 1, as seen by the intercept of vertical line OQ with yield versus alkali curve.

APPROACH II :

H—factor reduction with simultaneous yield gain :

In cook Nos. 5 and 6 compared to cook No. 2 the time at 165°C was reduced in two steps each of 30 minutes corresponding to H—factors of 1153 and 849 respectively. It was observed that the permanganate number was increased from 17.0 at 1457 H—factor (cook No. 2) to 21 2 at 849 H—factor (Table 1). As seen in fig. 1 the horizontal line at 20 5 permanganate number inter-sects the curve at P indicating a possible H-factor reduction to 960 for getting a permanganate number equal to that achieved during control cook No. 1.

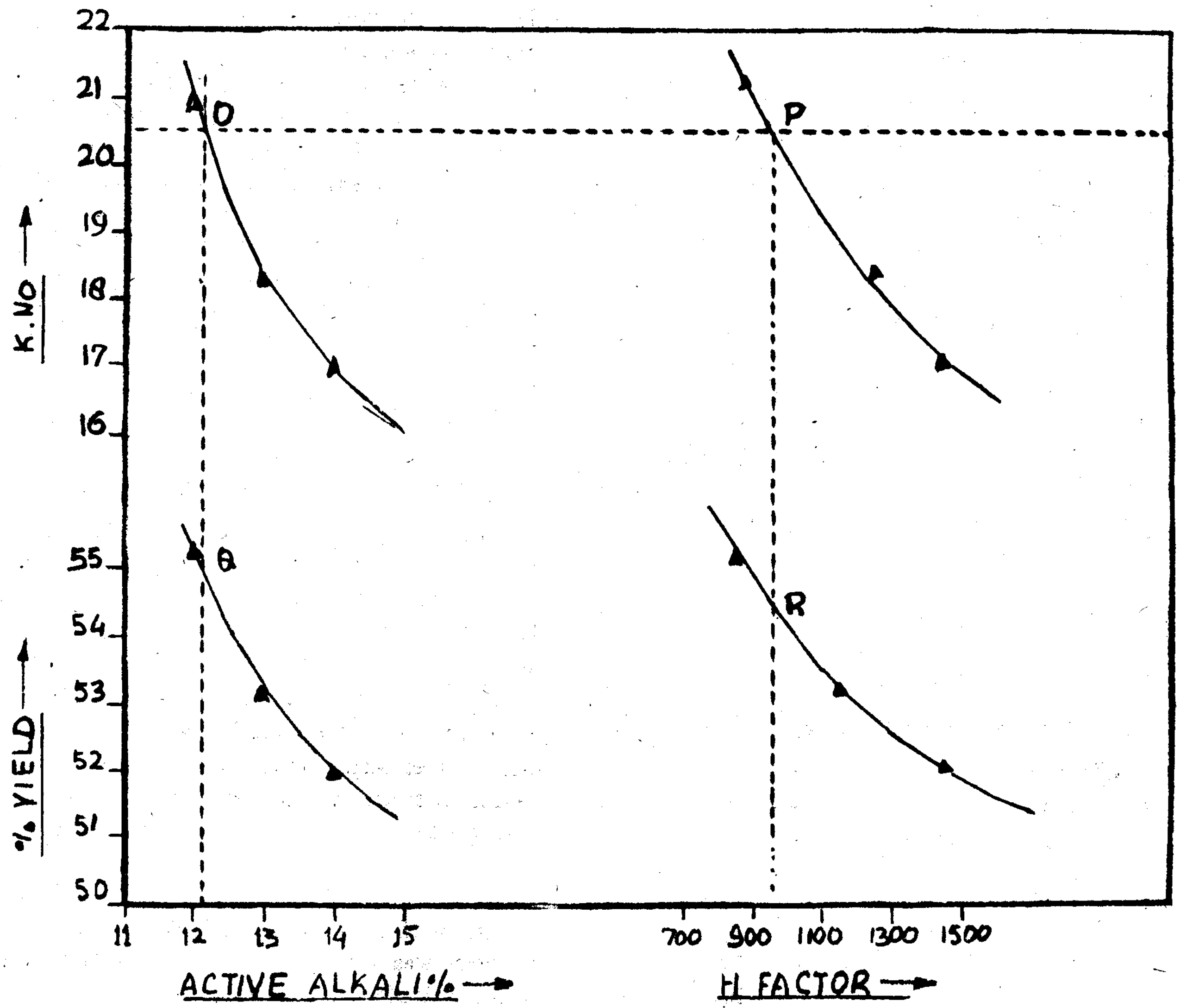
Also with H-factor 960, 0.05% AQ and 14% AA, the yield was more by about 1.4% as compared to control cook No. 1 as seen by the intercept of vertical line PR with yield H-factor curve.

TABLE 1

ANTHRAQUINONE SULPHATE PULPING OF *L. LEUCOCEPHALA*

Cook number	Active alkali %	AQ %	Temperature °C	Time Hrs.	H factor	K No.	Total yield %	Rejects %	Screened yield %
1	14	—	165	2 0	1457 39	20.5	53.1	0 4	52.7
2	14	0.05	165	2 0	1457.39	17 0	51.95	0.2	51.75
3	13	0.05	165	2.0	1457 39	18.3	53.2	0 3	52.9
4	12	0 05	165	2.0	1457.39	20.9	55.55	0.45	55.1
5	14	0 05	165	1.5	1153.24	18.4	53 4	0 6	52.8
6	14	0.05	165	1.0	849.09	21.2	55.40	1.1	54 30

PULPING PARAMETERS FOR AQ CATALYZED KRAFT PROCESS



In terms of time at 165°C, a saving of 30 minutes in each cooking cycle is possible using 0.05% AQ on O.D. raw material.

APPROACH III :

Reduction of bleaching chemical consumption :

Using a 0.05% dosage of AQ in pulping at the same AA charge, permanganate number was found to be reduced by 3 5 units. By this reduction of permanganate number it is expected that reduction in chlorine consumption of 2 to 2.5% on unbleached pulp can be obtained[17].

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