Chemical Additive for Accelerating Delignification Part - II - Kraft Pulping of Eucalyptus Tereticornis

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INTRODUCTION

The restricted supply of high quality pulp wood and the rising prices of utilities, will force paper mills to adopt new technologies to conserve energy, minimise inputs and maximise output, keeping environmental aspects in view. Much efforts have been directed towards finding a chemical pulping process giving higher pulp yield coupled with economic and environmental considerations. To date, no new methods has arisen to seriously challenge the kraft process and most efforst have been aimed at improving kraft pulp yield through protection of polysaccharides against progressive degradation, such as the peeling reaction[1,2,3]. As a potential replacement for the kraft process, the soda process suffers from low pulp yields and inferior quality, which are attributed to the excessively long cooking time and high temperature and caustic charges necessary to produce bleachable grade pulps. Application of an additive which offers a partial solution to this problem was reported long back[4] and its use in kraft and soda pulping was patented[5]. Very small amount of anthraquinone (AQ) and its derivative anthraquinone-2-monosulphonate sodium salt (AMS) were effective in accelerating the delignification. However, the cost benefit relationship is a barrier to their use. Other additives such as sodium borohydride or hydrazine are not commercially attractive because of their high costs. Polysulfide and hydrogen sulfide were actively pursued as pulping additives. These chemicals are in themselves inexpensive chemicals and may be economic to use as pulping additive due to the large yield increase obtained[6,7]. But these processes suffer from a requirement for significant capital investment and environmental aspects. Any viable replacement for the kraft process must retain its advantages while significantly reducing disadvantages. Ideally a new process should provide opportunities for capital cost reduction, give good pulp yield and quality and be compatible with existing kraft equipment with minimum disturbance.

As reported earlier by the authors the new chemical additive (LPH) explored, gave higher pulp yield, low kappa number and higher strength properties in case of bamboo. Chemical additive (LPH) is a phenolic in nature that can react with lignin during the process of delignification to form AQ/THAQ structures and thus acclerate delignification and stabilise carbohydrate to give higher pulp yield[8]. The studies were extended to *Eucalyptus tereticornis* and its advantage on pulp yield, kappa number and strength property of pulp was observed with respect to bleaching response and the results are discussed in the present paper.

EXPERIMENTAL

Eucalyptus tereticornis (300 gm O.D.) chips were cooked by Kraft process using LPH additive under following conditions:

Total active alkali	-	16%
Sulphidity	-	18%
Raw material to liquor ratio	-	1:3.5
Temperature of cooking	-	170°C
Time to 170°C	-	90 min
Time at 170°C	-	90 min
Chemical additive (LPH)	-	0.20 to 2.0%

The pulps were washed and screened in a vibratory screener. The total unbleached pulp yield was determined as usual.

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Kappa number The kappa number of pulps was determined as per TAPPI method.

Bleaching The pulps were bleached using CEH sequence under identical conditions. Two series of experiments were carried out. The total chlorine charge in first case was kept fixed (7.9% as available chlorine) on OD pulp basis, while in second case the total chlorine charge applied was based on of Kappa number (K. No. x. 0.22 = total chlorine demand) of pulps. The bleached pulp yield was determined.

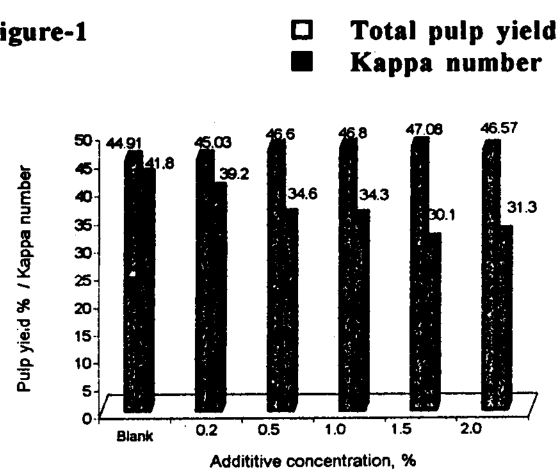
Pulp Evaluation The screened pulps were beaten in PFI mill to a freeness level around 250 ml. Standard sheet of 60 ± 2 gsm were prepared. Strength properties of pulp sheets were determined as per ISO methods.

Brightness Brightness of pulp pad was determined using Elerepho 2000 data color Brightness tester.

RESULTS AND DISCUSSION

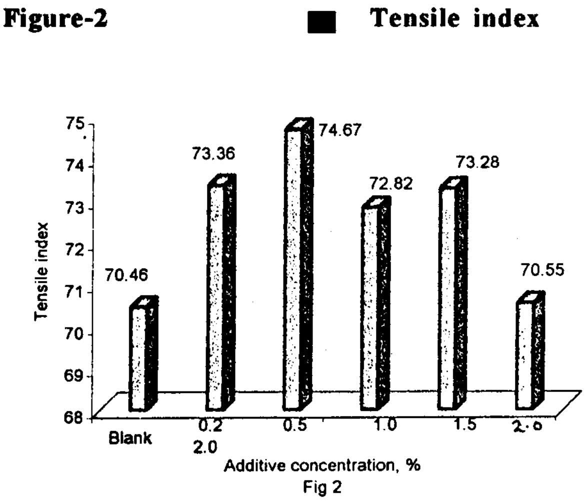
Pulp yield and kappa number results from kraft pulping with and without addition of chemical additive (LPH) found affective and are presented in Fig.-1. Addition of chemical additive (0.20 to 2%) registered 0.27-4.8% pulp yield (on blank pulp yield) advantage was obtained over the conventional kraft (blank) under identical pulping conditions. The pulp yield gained at 0.5% and 1.05 addition was 3.8% and 4.2% against blank. Addition of 1.5% chemical provided maximum pulp yield (4.8%) improvement. There was no increase in pulp yield at 2% addition of chemical additive.

Figure-1



Effect of additive concentration on pulp yield and kappa number of unbleached pulp

Figure-2



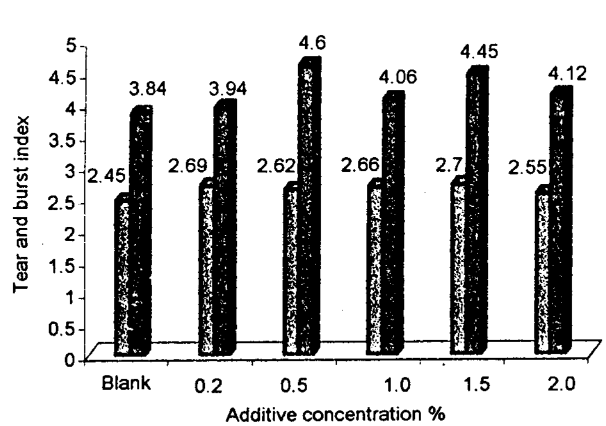
Effect of additive concentration on tensile index of unbleached pulp

To assess the effectiveness of chemical additive, high kappa number pulp was produced. The kappa number obtaied with chemical additive addition is dropped form 41.8 to 30.1 i.e., 27.9% reduction in kappa number was achieved. The reduction in kappa number with higher pulp yield in comparison to blank may be due to the stabilization of polysaccharides and disintegration of beta-phenyl ether bond. It is understood that even 1% increase in pulp yield will result in enormous saving of raw material and maximising production keeping economics of the additives cost. Reduction in kappa number is an added advantage and will definitely economise bleaching inputs.

STRENGTH PROPERTIES OF UN-BLEACHED PULP

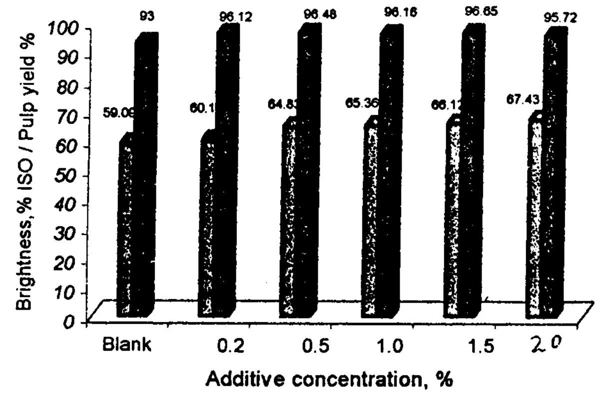
The strength properties in terms of tensile index, tear index and burst index of unbleached pulp are depicted in Fig. 2 and Fig 3. The pulp produced with chemical additive registered improvement in strength properties i.e., tensile, burst and tear indices rose by 5.9%, 10.2%, 19.8% respectively as compared to blank pulp.

Figure-3



Effect of additive concentration on tear and burst index of unbleached pulp

Figure-5



Effect of additive concentration on brightness and pulp yield (charge on the basis of kappa number)

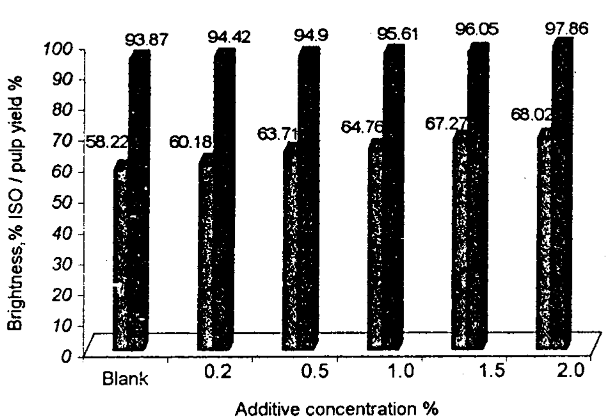
BRIGHTNESS AND PULP YIELD OF BLEACHED PULP

For a preliminary comparative study on the bleachability of pulps conventional CEH sequence was employed to bleach the pulp yield and brightness advantage among the pulps obtained with chemical additive was observed (Fig 4 and Fig 5). At fixed chlorine charge the brightness increased by 16.8% (Fig 4). When total chlorine was charged on the basis of kappa number the brightness improvement was from 59.9 to 67.43. The results indicate that chemical additive results in production of bleachable grade pulp and lignin present in the pulp is easily accessible during bleaching treatment as compared to blank.

STRENGTH PROPERTIES OF BLEACHED PULP

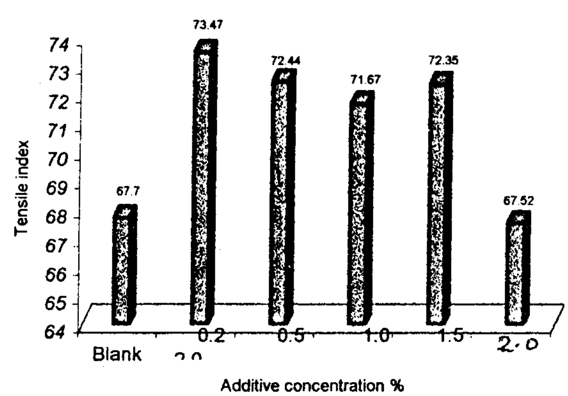
Fig. 6 and Fig. 7 reflect the strength reflect the strength properties of bleached pulps in terms of

Figure-4



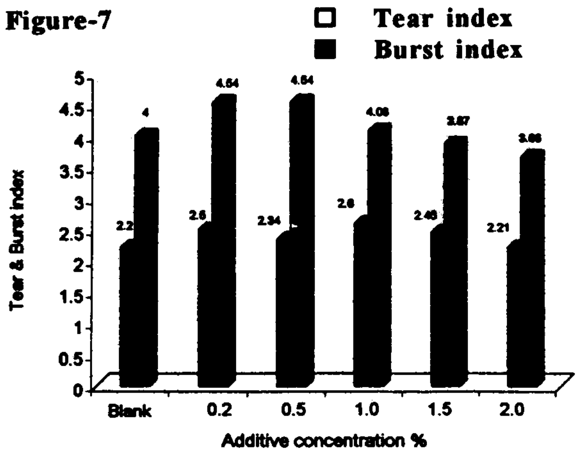
Effect of additive concentration on brightness and pulp yield (with 7.9% available chlorine)

Figure-6



Effect of additive concentration on tensile index of bleached pulp (with 7.9% available chlorine)

Figure-7



Effect of additive concentration on tear and burst index of bleached pulp (with 7.9% available chlorine)

tensile index, tear index and burst index. It is observed that upto 1.5% chemical additive treatment improve tensile, tear and burst by 8.5%, 18.2%, 13.5% in case of pulp bleached with 7.9% available chlorine.

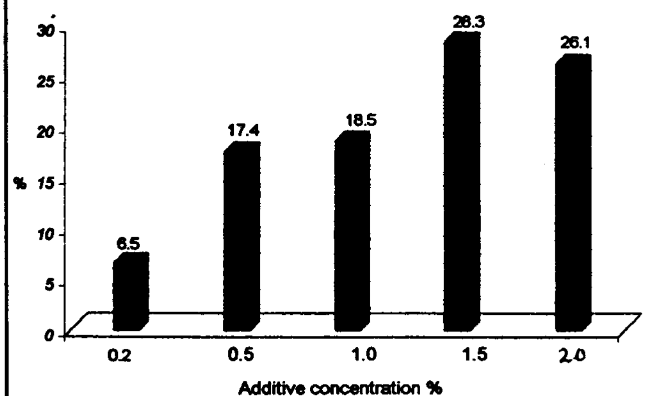
In case of pulps obtained with chemical additive when bleached, showed higher strength properties and higher brightness in comparison to blank may be due to more solubilization of lignin and stabilization of polysaccharides even at higher pulp yield.

Use of this lignin based chemical additive in chemical pulping for improving the pulp yield without impairment in strength properties and bleachability showed that in situ modification of degraded lignin during pulping to produce compounds akin to anthraquinone, is very effective in accelerating delignification and carbohydrate stabilization resulting in increased pulp yield.

REDUCTION IN CHLORINE DEMAND

Figure 8 has clearly shown that chemical additive treatment reduced the chlorine demand upto 28.3%

Figure-8



Percent reduction in total chlorine demand

during bleaching thus reducing the cost of bleaching. Further investigations on economic aspects of the process with ECF/TCF bleaching sequences are in-progress.

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