Chemical Additives for Accelerating Delignification

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ABSTRACT

The quinone additives are being available for their use as pulping additives with an aim to improve pulp yield, quality of pulp and reduce chemical consumption and energy. Pulping of wood in alkaline liquor containing small charge of anthraquinone (AQ) or its derivatives can be improved considerably. These chemicals act as polysaccharide stabilize and delignification accelerate in kraft/soda pulping. However the cost of AQ could be a limiting factor. Therefore researches are being carried out on identification of cheaper additives similar to anthraquinone. In the present paper attempts have been made to add chemical having phenyl structure (Ph) in the initial stage of cooking. The increase in pulp yield, decrease in kappa number and increase in strength was observed.

INTRODUCTION

Several years ago, when efforts were intensified to alleviate environmental problems, the possibility of replacing the kraft pulping process was seriously considered. In addition, considerations of economics focussed attention on another negative aspect of the kraft process its lack of selectivity for delignification, low pulp yield etc. These facts aroused considerable interest in discovering compounds which, when added to alkaline cooking liquors, would tend to protect the carbohydrates against degradation (Clayton, Stone, 1963, Clayton, 1970) thus conserving pulp yield from wood. Further, if such compounds contained no sulphur, and could eliminate sodium sulphide from kraft liquor, further gains might be achieved towards solving the problems of air pollution arising from the organic sulphur containing compounds generated by the action of sodium sulphide on wood components.

A new outlook was brought to alkaline pulping with Holton's (1977) discovery that the pulping of wood in alkaline liquor containing small charges of anthraquinone (AQ) or some of its derivatives anthraquinone monosulphonate (Ghosh, V., 1977), can be improved considerably using anthraquinone and related compounds as polysaccharide stabilizer and delignification accelerator in kraft/soda pulping to improve pulp yield, quality of pulp and reduced chemical consumption and energy has been established (Singh, S.V. 1991). However the cost of AQ could be a limiting factor. Therefore researches are being carried out on identification of cheaper additives similar to AQ. In this context the application of 2-benzoyl-benzoic acid in soda pulping was studied (Singh, S.V., 1991). It was observed that with 2-benzoyl benzoic acid the yield increase was 1.4 per cent and this substitute compound has been effective in stabilization of carbohydrate and did not influence

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rapid delignification. In case of kraft pulping, addition of 0.2 percent 2-benzoyl benzoic acid increased pulp yield by 3.1 per cent and the degree of delignification remain unchanged. Effect of sodium xylene sulphonate and dodecylbenzene sulphonate sodium salt as additives in pulping was examined (Singh, S.V. 1991). Soda amine (particularly soda-ethylenediamine (EDA), and soda-AQ/EDA pulping and their effect on pulp strength properties and bleachability was studied (Kubes et al, 1971). Exploration of soda amine pulping was terminated when the possibility of developing an economical process become more remote due to high charge of additive (at least 20% but more likely 40% on oven dry wood), a sharp increase in the price of EDA over the few years.

In the present paper attempts have been made to add chemical having phenyl structure in the initial stage of cooking which reacts with lignin during the course of delignification and possibly could form additive very similar to AQ. Thus lignin based additive (LPh) formed could accelerate the rate of delignification and retard the carbohydrate degradation. The paper gives an account of the results of preliminary experiments carried out on kraft/additive pulping of bamboo.

RESULTS AND DISCUSSION

The chemical additives basically quinone compounds have become the chemicals absolutely essential and the distinct role of the quinone to delignification has been made clear. Two fundamental functions of cooking additives are as follows:

1. Accelerating of delignification (distintegeration of betaphenylester bond)

2. Stabilisation of cellulosic materials (oxidation and terminal aldehyde groups of carbohydrates of polysaccharide).

POSSIBLE REACHTION MECHANISM OF FORMATION LPH (COOKING ADDITIVE WITH Ph CHEMICAL)

Zhigalov and Tishchenko (1962) were of the opinion that the function of sulphide ion in kraft pulping is to participate in oxidation reduction reactions with lignin. The ph chemical during the course of pulping hydrolyse and subsequently undergo reduction below 130°C and further oxidised to form acid. The acid compound formed undergoes dehydrogenation at elevated temperature and combine with oxidissed product of lignin and results into LPh chemical similar to AQ.

GAINS OF PULP YIELD AND KAPPA NUMBER

From the view point of economy in applying the chemical additive cooking, the gain in pulp yield is very important. As apparent from Table-1 that the pulp yield increases with increase of Ph chemical addition. The increase in the pulp yield is in the range of 1.4%, 1.90%, 2.5%, 3.8% at 0.5%, 1.0%, 1.5%, 2.0% addition of Ph chemical addition during initial stage of cooking. Although the increase in pulp yield about 3.8% at 2% addition of Ph chemical is significant but the cost of Ph chemical has to be seen. The increase in pulp yield is due stabilisation cellulose material by oxidation of terminal aldehyde groups of carbohydrates of polysaccharide. The reduction in kappa number is also observed in the way and reduction of kappa number at higher pulp yield is due to disintegration of beta phenyl ester bond.

STRENGTH PROPERTIES OF PULPS SHEET

The evaluation of pulp as tabulated in Table-2 showed that the tensile index increases from 8.13%

TABLE -1

Effect of lignin chemical additive on kappa number & Pulp yield

% Ph. Doses added	Kappa number	Pulp yield, %
Nil	25.94	47.3
0.5	23.32	48.01
1.0	20.58	48.2
1.5	19.92	48.5
2.0	17.34	49.09

Based on o.d. raw material.

TABLE -2

Strength properties of pulp produced with LPh chemical

Sample	Basis Wt. g/m²	Apparent density g/cm³	Tensile index Nm/g	Tear index mNm²/g	Burst index kPam²/g	Fold kohler Molin log
Blank	65.4	0.73	67.28	4.83	4.19	944
1	63.4	0.70	72.75	4.97	5.10	944
2	64.3	0.73	75.61	5.14	5.20	796
3	64.9	0.66	78.93	5.12	5.31	632
4	63.8	0.73	80.06	5.10	5.53	580

to 18.95 with increase of additive. The tensile index in case of blank is 67.28 Nm/g and at 0.5%, 1.0%, 1.5%, 2.0% addition of additive it is increased to 72.75, 75.61, 80.06 Nm/g. The tear index increases upto 1.0% addition, from 4.83 to 5.14 mNm²/g. Burst index at the same way increases with increase of additive whereas Fold decrease from 944 to 580.

Nevertheless, the present investigation proved to be extremely worth while in providing new sights into the general mechanism of alkaline delignification. The work on time temperature and saving of active alkali is in progress.

EXPERIMENT

200 gm o.d. bamboo chips were cooked by kraft process under following conditons.

Total active alkali	16%
Sulphidity	20%
Temperature cooking	170°C
Time to 170°C	90 min
Time at 170°C	90 min

Ph (Chemical) doses-0.5%, 1.0%, 1.5% and 2.0%

Kappa Number: The kappa number of pulps were determined as per Tappi method.

Pulp evaluation: The screened pulps were beaten in PFI mill to a freeness level around 200 ml standard for strength properties after conditioning at 65 percent humidity and 20°C.

REFERENCES

1. Clayton, D.W., Stone, J.E. (1963). The redeposition of hemicelluloses during pulping. Part-I Pulp Pap. Mag. Can. 64 : T459-469.
2. Clayton, D.W. (1970). Has success spoiled kraft pulping trend (P.P.R.I.C.) : 7:12.
3. Holton, H.H. (1977). Soda additive softwood pulping a major new process, Pulp Pap. Can. 78, T 218-223.
4. Ghosh, K.L. and Chin, W.J. (1977) Tappi, Vol. 60, No. 11.
5. Singh, S.V. (1991) Nordic Pulp and Paper Res. J. No. 1.
6. Kubes, G.J., Bolker, H.I. (1978) Sulphur free delignification I. Alkaline pulping with monoethanolamine and ethylene diamine Cellul. Chem. Technol. 12 : 621-645.
7. Zhigalov, Yu. V., Tishchenko, D.V. (1962) Sulphur in thiolignins Zhur. Prikc. Khim. 35 : 147-153.