Effect of Delay at Cooking Temperature on Kraft Pulp & Strength Properties of Eucalyptus Hybrid

Unkalkar V.G., Pai N.M., Maheshwari Subhash*

Summary

Dabarked Eucalyptus hybrid chips were used to study the effect of delay at a cooking temperature of 165°C., keeping other cooking parameters unchanged. Unbleached pulps thus obtained were tested for yield, shade, Kappa number, viscosity, fibre proportions and strength properties. pH and residual active alkali in black liquor were determined.

Due to delay at cooking temperature, a continuous drop in pH and residual active alkali of black liquor was observed. As the delay at 165°C increased, there was a reduction in pulp yield and viscosity, change in shade, reduction in proportion of long fibres and reduction in strength properties of beaten pulp. Necessary corrective measures are required to be taken under such a conditions to avoid adverse effects on pulp quality.

Introduction

The uniformity of the pulp depends mainly on raw material, chips size, chemicals, liquor to wood ratio, cooking schedule, cooking temperature and time at cooking temperature etc. Any alteration in any of these factors influences the pulp quality. The literature is available on various parameters mentioned above but very little information is available on the parameter "time at cooking temperature".

The magnitude of temperature determines the rate of pulping. The rate of delignification is approximately doubled for every 10°C rise in temperature. Time at temperature is most crucial part of a cook as far as degradation of cellulose is concerned as more and more cellulose gets exposed to direct action of alkali in liquor(1).

Minimum time for a complete cook of hardwood was half an hour at 170°C. after 1.5 hours for raising the temperature to this level. A delay for 3 hours at 170°C. slightly reduced the lignin content of pulp but reduced pulp yield. (2) Influence of cooking temperature and time on pulp yield and degree of delignification has been discussed. (3).

Cooking of wood has a major effect on the operation of pulp mill not only because it is the first step in papermaking but because the degree of uniformity attained in cooks materially affects the operation that follows(4).

If precise control of cooking cycle is not possible for any reason, H-factor can be calculated by adjusting time-temperature relationship and the combination of these variables can be chosen to fix the time of digestion(5).

Thus the parameter, cooking time at temperature, is important from the fact that in plant there is a delay in blowing for various reasons such as non-availability of space in blow tank, improper supply of steam and maintenance problems associated with further processing etc. In such cases, the cooked chips are left in the digester itself, may be at any temperature or at cooking temperature itself for longer time. This affects the quality of pulp obtained. This paper deals with the delay at cooking temperature maintaining other parameters unchanged.

For the study, debarked Eucalyptus hybrid was chosen as a raw material. The cooking temperature was fixed (165°C.) and time at maximum temperature was varied. The normal pulping condition selected was one that is used in our mills regularly for pulping of Eucalyptus hybrid chips. Apart from the normal cooking schedule, the "delay" in cooking was manipulated at maximum cooking temperature of 165°C. in the range of half an hour to eight hours. Then, the effect of delay on pulp quality and strength properties was studied.

Experimental

Adequate quantity of debarked Eucalyptus hybrid logs were selected from wood yard and chipped in mills Pallmann Chipper. The chips were then screened and -32 + 3 mm fraction was taken for experimental purpose after uniform air drying.

To determine the quantity of white liquor and also to study the effect of delay at 165°C., two sets of pulping experiments were carried out using 16 and 17% chemicals active alkali as Na_2O. The sulphidity of white liquor was 20%. In each set, 6 experiments were carried out by

*Research Centre, The West Coast Paper Mills Ltd., P.B. No. 5, Bangurnagar, Dandeli, India- 581 325.

maintaining the temperature at 165°C. for periods varying from 1 to 9 hours, considering the normal cooking period of 1 hour, at 165°C. In each case, pulp yield, brightness, rejects, kappa number, viscosity of pulp, Bauer McNett fibre fractions, pH and residual active alkali of black liquor etc. were determined. The cooking conditions and results are tabulated in Table No. I and II. Graphs of delay at 165°C. against various pulp properties and black liquor residual

Table No. I

AUTOCLAVE PULPING OF E-HYBRID AT 16% CHEMICALS

Particulars	1	2	3	4	5	6
Delay at 165°C., Hrs.	0	1/2	1	2	4	8
Pulp brightness, % Elrepho	31.0	31.3	31.3	28.4	27.0	22.1
Pulp yield, % on chips	48.4	48.0	47.3	47.0	46.3	46.3
Rejects, % on chips	0.4	0.3	0.3	0.3	0.4	0.3
Kappa Number	22.5	21.8	19.7	16.9	18.8	19.3
Residual Active Alkali, gpl as Na_2O	5.3	4.3	3.7	2.8	2.5	2.5
pH of W.B.L.	12.6	12.4	11.9	11.7	11.3	11.0
Unbleached pulp viscosity, cP. (CED)	18.2	16.4	15.5	14.6	12.7	12.3
Fibres retained, %						
+ 35 mesh screen	29.7	28.5	27.6	26.4	22.6	18.0
- 35 + 50 mesh screen	24.3	26.4	27.1	28.2	30.4	29.4
- 50 +100 mesh screen	25.4	25.4	23.8	26.1	27.6	26.7
- 100 mesh screen	20.6	19.7	21.5	19.3	19.4	25.9
Constant Cooking Conditions:						
Chemicals as Na_2O on chips, %	..	16.0				
Bath ratio	..	1:3				
White Liquor Sulphidity, %	..	20.0				
Time from 70-120°C., Min.	..	45				
Time at 120°C., Min	..	45				
Time from 120-165°C., Min	..	90				
Time at 165°C., Min	..	60				

Table No. II

AUTOCLAVE PULPING OF E-HYBRID AT 17% CHEMICALS

Particulars	1	2	3	4	5	6
Delay at 165°C., Hrs.	0	1/2	1	2	4	8
Pulp brightness, % Elrepho	34.2	34.8	33.3	30.7	30.3	25.4
Pulp yield, % on chips	47.2	46.5	46.0	45.7	45.5	45.2
Rejects, % on chips	0.4	0.3	0.4	0.4	0.3	0.3
Kappa Number	21.0	19.1	17.8	16.7	14.7	16.2
Residual Active Alkali, gpl as Na_2O	8.1	7.4	6.8	5.3	5.1	4.0
pH of W.B.L.	12.8	12.6	12.5	12.1	11.7	11.2

Unbleached pulp viscosity, cP. (CED)	19.6	17.7	16.8	15.0	13.2	10.9
Fibres retained, %						
+ 35 mesh screen	28.6	27.6	27.8	26.1	25.1	13.7
- 35 + 50 mesh screen	25.9	27.4	28.5	29.8	33.8	36.4
- 50 +100 mesh screen	23.4	24.1	22.6	23.7	22.7	25.3
- 100 mesh screen	22.1	20.9	21.1	20.4	18.4	24.6

Constant Cooking Conditions:

Chemicals as Na_2O on chips, %	..	17.0
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White Liquor Sulphidity, %	..	20.0
Time from 70-120°C., Min.	..	45
Time at 120°C., Min	..	45
Time from 120-165°C., Min	..	90
Time at 165°C., Min	..	60

active alkali were plotted (Fig. 1 and 2).

To study the effect of delay on strength properties of pulps, each pulp from set No. 2 i.e. 17% active alkali was separately beaten in a laboratory Valley beater to 30°SR and sheets of 60±1 gsm prepared on British Sheetmaking machine. These sheets were then conditioned at 65% R.H. and 25°C. and tested for various strength properties. The results are as shown in Table No. III. The graphs of delay against some of the strength properties are given in Fig. 3.

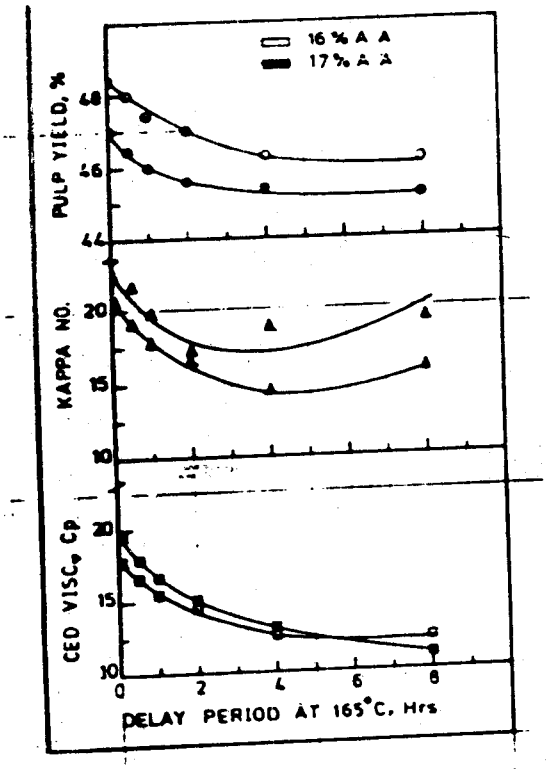

Fig:1. EFFECT OF DELAY PERIOD ON PULP PROPERTIES

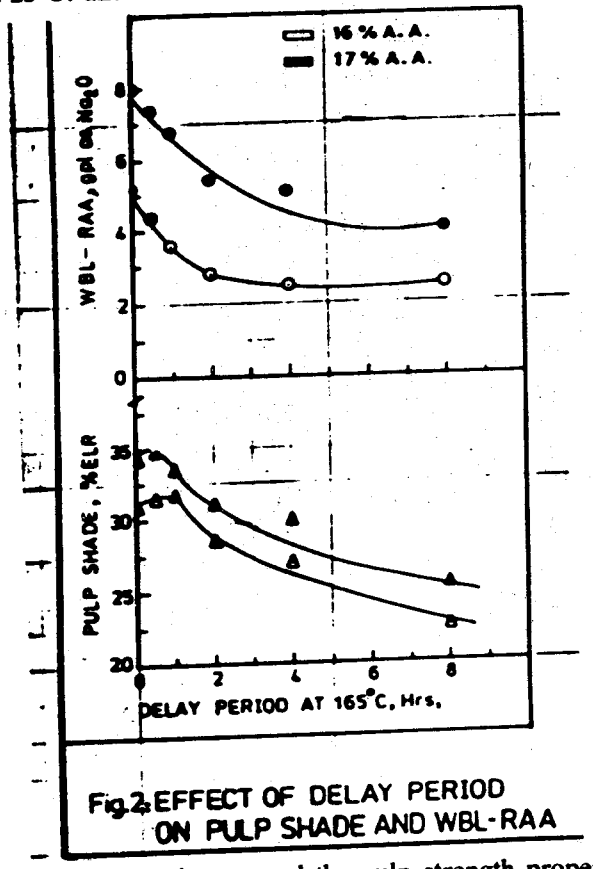

Fig.2. EFFECT OF DELAY PERIOD ON PULP SHADE AND WBL-RAA

Results and Discussion

Following observations can be made based on the data on pulping experiments and the pulp strength properties (Table I to III and Fig. 1 to 3):

a) Initially, the pulp brightness/shade increases during first hour of delay. Then, it starts reducing with

Table No. III

STRENGTH PROPERTIES OF UNBLEACHED E-HYBRID PULPS AT 30°SR

Particulars	1	2	3	4	5	6
Beating time, Min.	14	14	14	14	14	14
Bulk, cm3/g.	1.75	1.79	1.86	1.84	1.84	1.89
Breaking length, Kms.	5.67	5.03	5.10	4.87	4.31	4.24
Stretch, %	2.8	2.8	2.8	2.7	2.7	2.7
Burst factor	44.6	42.3	41.0	35.8	35.0	32.1
Tear factor	97.4	90.3	90.6	78.6	74.9	69.5
Folding endurance (MIT)	33	30	28	20	13	12
Bendtsen porosity, ml/min.	1400	1600	1800	1800	2000	2000
Strength index No.*	1870	1780	1750	1540	1430	1340

*[Burst factor x Tear factor x log folding endurance]$^{1/3}$x 100

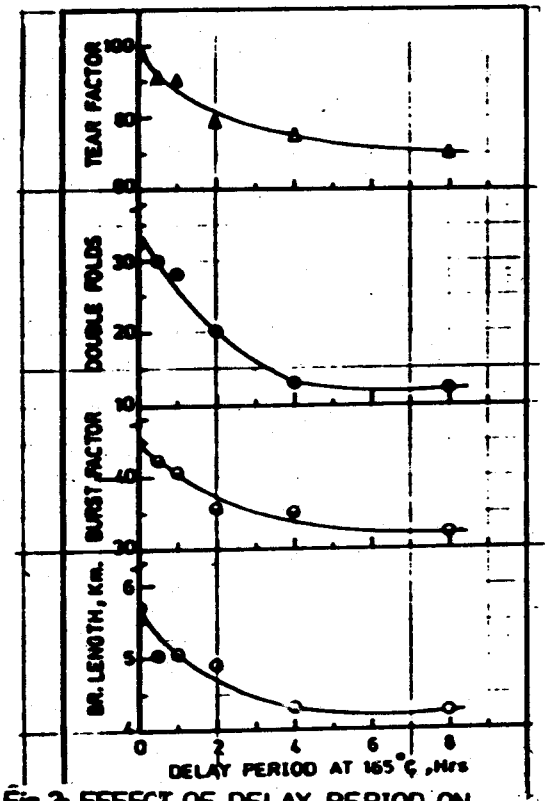

Fig.3: EFFECT OF DELAY PERIOD ON STRENGTH PROPERTIES

increase in the delay period. This reduction in brightness is 9-10 points between its maximum and minimum values.

b) There is a steady fall in the pulp yield. About 2% reduction in pulp yield has been observed when delay is increased to 8 hours when compared to a normal cook.

c) Kappa number of pulp decreases initially but after about 4 hours of delay it starts increasing. This may be because of minimum quantity of residual alkali left for reaction to proceed with subsequent deposition of lignin and colouring matters. This is indicated by brightness reduction and confirmed by continuous decrease in weak black liquor pH and residual alkali with increasing delay.

d) There is a continuous drop in pulp viscosity from 18-20 cp. of normal cook to 11-12 cP. of the cooks delayed for 8 hours indicating the degradation of cellulose.

e) Data on Bauer McNett fibre classification show that long fibre (+35 mesh) fraction falls at a steady rate initially till two hours delay. It drops steeply further when delay is increased to 8 hours, thus increasing the short fibre fraction accordingly.

f) As expected from the viscosity drop, the strength properties of unbleached pulps [Table No. III and Fig. 3], especially burst factor, tear factor, folding endurance and breaking length go on reducing. This can be clearly seen from the drop in strength index as of 1870 for the pulp from normal cook to 1340 for the pulp from the cook delayed for 8 hours.

Conclusion

It can be concluded from the present study that delay in cooking, particularly at maximum temperature, more or less proportionately affects adversely the pulp and black liquor characteristics. Hence, efforts are required to avoid the delay in a blow of the digester. If it is unavoidable

necessary corrective measures i.e. proper planning, rescheduling of cooking and maintaining the required 'H' factor etc. are to be taken to prevent the deterioration of pulp quality.

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