Alkali Leaching in Final Washed B.S.W. Pulp and its effect on Bleached Pulp Quality

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Abstract

Mixed cooking of bamboo and hard woods (65:35) generate higher fines when unbleached pulp Kappa No is brought down from 25-26 to 18-20 which in turn affects the Paper machine runnability. Kappa No reduction achieved by hot alkali extraction in bleaching dissolve relatively less carbohydrates than that through direct cooking. Delignification studies of final washed B.S.W pulp with 2%, 3% & 4% NaOH at 60°C, 75°C & 85°C were carried out for 60 minutes at 10% pulp consistency. At 85°C final washer pulp Kappa and higher 29.4 Kappa were delignified with 2%, 3% and 4% NaOH. The Kappa No of delignified pulp was reduced by 4 to 5 points compared to final washed screened pulp. It is observed that 2% alkali addition for delignification in bleaching is the optimum dosage to obtain desired bleached pulp viscosity. The chlorine consumption of delignified, final B.S.W screened pulp under CEpHD sequence was lower by 15 to 20% as compated to screened washed bleached pulp. Reduction in chlorine consumption also helps to bring down the pollution load, especially reduction in AOX. Strength properties of 2% NaOH delignified unbleached and bleached pulps are observed to be higher than 3% NaOH delignified pulps from either lower or higher Kappa No pulps.

INTRODUCTION

Bamboo (from U.P., M.P. and Assam) and mixed hard woods (Eucalyptus, Subabool, Casurina and other local hard woods) in 65:30 ratio ratio are cooked in Stationary Digesters in mill. The two raw materials are heterogeneous in nature and consume different percentage of alkali to produce bleachable grade pulp. Bamboo and hard woods cooked together result in drastic cooking conditions for bamboo and hence higher percentage of fines are generated when unbleached pulp with 25-26 kappa is brought down to 18-20 which ultimately affects the paper machine runnability. Kappa No. reduction achieved by hot alkali extraction than that by direct cooking dissolve relative less carbohydrate than cooking. The release of lignin compounds from cooked and washed pulp fibres can be enhanced under suitable delignifying conditions. However the mechanism of lignin transfer is complex. The rate and extent to which dissolved lignin can be released from within the fibres are governed by diffusion and sorption phenomena as well as by molecular size, porosity and structure of cell wall matrix (1). Diffusion is strongly dependent on pH and temp erature (2,3). At higher pH and elevated temperature (4) lignin reacts (5) with free alkali but begins to precipitate at pH below 10. The fibre swelling that occurs under alkaline conditions has favourable impact on transfer of lignin from fibres. At higher pH, lignin leaching is significant even with moderate retention time, medium consistency, moderate temperature and initial low Kappa No. (6).

Increasing the temperature during leaching dramatically increases the rate of lignin removal (7). Therefore by increasing the retention time, temperature and pH of washing, a mill can reduce bleaching and effluent treatment cost (8). Alkali added to facilitate delignification or leaching has to be suitably recovered since Sodium equilibrium is achieved quickly in pulp (9).

In the present investigations pulp from third Brown Stock washer was treated with different alkali dosages and subjected to temperature variations under constant leaching conditions of time and consistency. Based on the findings the work was further extended using lower and higher Kappa No. of final washed pulp and alkali dosages were applied at higher temperature of 85°C under

Table 1. Effect of temperature and alkali dosage variation on washed unbleached pulp quality from

Final stage of B.S.W. **Blank Pulp Kappa No. 25.3**

Particular	1st Set of alkali leaching			2st Set of alklai leaching			3st Set of alkali leaching		
	Expt. No. 1	Expt. No. 2	Expt. No. 3	Expt. No. 4	Expt. No. 5	Expt. No. 6	Expt. No. 7	Expt. No. 8	Expt. No. 9
Caustic applied, %	2.0	3.0	4.0	2.0	3.0	4.0	2.0	3.0	4.0
Reaction Temp. °C	60	60	60	75	75	75	85	85	85
End pH	11.3	11.7	12.0	11	11.5	11.7	10.5	11.0	11.5
Kapp No. of pulp	21.3	21.0	20.6	21.2	20.8	20.6	20.3	19.7	19.2
Constant alkali leaching conditions Reaction time, mts--60, Consistency % 10.0									

Table 2. Effect of alkali dosage variation on washed unbleached pulp quality from final stage of B.S.W.

(i) Blank Pulp Kappa No. 26.3, (Containing screen reject 0.58%)
(ii) Screened Pulp Kappa No. 22.6

Particular	Alkali leaching effect on $B.S.W_3$ Pulp quality			
	Blank Expt. No. 1	Blank Expt. No. 2	Blank Expt. No. 3	Blank Expt. No. 4.
Caustic applied, %	-	2.0	3.0	4.0
End pH	9.9	10.8	11.3	11.8
Reject	0.57	0.49	0.48	0.39
Screened pulp Kappa No	20.4	19.0	18.0	17.8
Constant alkali leaching conditions Reaction time, mts--60, Consistency % 10.0, Temp. °C --85±1				

constant delignification conditions of time and consistency. The pulps after delignification were bleached under CEpHD sequence and evaluated for strength properties.

EXPERIMENTAL

Washed unbleached pulp from final stage of B.S.W having 25.3 Kappa in set No1, 2 and 3 was treated with 2.0%, 3.0% and 4.0% alkali at 60°C, 75°C and 85°C. The pulp consistency and reaction time was kept constant. The delignification conditions and results are recorded in Table 1.

Final washed pulp from B.S.W was screened before carrying out leaching / delignification experiments. The screened pulp of 22.6 kappa was treated with 2.0%, 3.0% and 4.0% NaOH at higher temperature 85 ±1°C. The end pH and Kappa No reduction of alkali treated pulps is compared with blank experiment in Table 2. Alkaline delignification conditions kept constant were reaction time (60 minutes) and pulp consistency (10%). Final washed and screened pulp of B.S.W of 22.6 Kappa, Blank experiment of 20.4 Kappa, 2% alkali treated pulp of 19.0 Kappa and 3.0% alkali treated pulp of 18.0 Kappa were bleached under CEpHD sequence for 87±1% P.V. brightness. The bleaching conditions and results are recorded in Table 3. Physical strength properties of bleached pulps from different delignified pulps, beaten at 30°SR freeness are recorded in Table 4.

Final washed pulp from B.S.W of 31.6 Kappa was screened before carrying out delignification with NaOH. The screened pulp of 29.4 Kappa was treated with 2%, 3% and 4% NaOH at 85± 1°C. The end pH and reduction in Kappa No is compared with blank experiment in Table 5. Alkaline delignification conditions kept constant were reaction time (60 minutes) and pulp consistency (10%).

Table 3. Bleaching of washed pulp of lower kappa no. final stage of B.S.W. (after alkali leaching) under CEpHD sequences

Particular	Screened final washed pulp of B.S.W. Kappa No. 22.6 Expt. No. 1	(without alkali treatment) Kappa No. 20.4 Blank Expt. No. 2	Final washed pulp of B.S.W. treated with alkali	
			Kappa No. 19.0 Expt. No. 3	Kappa No. 17.6 Expt. No. 4
Chlorination stage				
i) Cl_2 applied/consumed, %	4.4/4.0	4.1/3.7	3.8/3.4	3.5/3.1
ii) End pH	2.6	2.6	2.5	2.6
Alkali extraction stage				
i) NaOH applied, %	1.8	1.7	1.4	1.3
ii) H_2O_2 applied, %	0:4	0.4	0.4	0.4
iii) End pH	10.6	10.7	10.5	10.5
Calcium hypochlorite stage				
i) Hypochlorite applied/ consumed, % as available Cl_2)	2.5/2.3	2.2/2.0	2.2/1.8	2.0/1.7
ii) Sulphamic acid, %	0.1	0.1	0.1	0.1
iii) Buffer added, %	0.6	0.6	0.6	0.5
iv) End pH	9.3	9.4	9.7	9.0
Chlorine dioxide stage				
i) ClO_2 applied/consumed, %	0.6/0.55	0.6/0.54	0.6/0.53	0.6/0.55
ii) End pH	5.3	6.0	6.8	5.8
Final Results				
i) Total Cl_2 applied/ consumed, %	6.9/6.3	6.3/5.7	6.0/5.2	5.5/4.8
ii) Total ClO_2 applied/ consumped, %	0.6/0.55	0.6/0.54	0.6/0.53	0.6/0.55
iii) Pulp brightness, % P.V.	87.0	86.5	87.0	86.5
iv) Pulp viscosity, (0.5% CED, Cps)	6.8	7.4	7.3	7.8
v) P.C. No.	2.6	2.05	1.8	1.89
Constant bleaching conditions				
	C	**E**	**H**	**D**
Consistency %	3.0	10.0	10.0	10.0
Temp. °C	Room	60±1	40±1	70±1
Time, mts.	60	60	120	120

Table 4. Physical strength properties of washed pulp from final stage B.S.W (alkali treated) and CEpHD sequences bleached pulps

Particular	Final washed pulp from B.S.W., bleached under CEpHD sequence			
	Expt. No. 1	Expt. No. 2	Expt. No. 3	Expt. No. 4
Initial Freeness, °SR of pulp	14	14	14	14
Number of beating revolution in P.F.I. Mill	4300	4400	4500	3900
Final Freeness, °SR of pulp	31	2	31	29
Bulk, c.c./gram	1.44	1.42	1.4	1.4
Tensile Index, N.m/g	50.27	53.85	54.40	52.28
Burst Index, K.Pa.m²/g	3.8	3.9	3.95	3.49
Tear Index, N.m²/g	6.7	6.8	7.01	6.6
Double fold	151	176	223	104

Table 5. Effect of alkali dosage variation on of washed unbleached pulp quality from final stage B.S.W

(i) Blank pulp kappa No. 31.6 (having screen reject 1.5%)
(ii) Screened pulp kappa No. 29.4

Particular	Alkali leaching effect on final washed pulp quality from B.S.W			
	Blank Expt. No. 1	Expt. No. 2	Expt. No. 3	Expt. No. 4
Caustic applied, %	-	2.0	3.0	4.0
End pH	9.8	10.7	11.1	11.6
Reject	1.48	1.4	1.38	1.39
Screened pulp kappa no.	26.9	25.6	25.3	25.1
Constant alkali leaching conditions Reaction Time, mts. -----60, Consistency % ----10.0, Temp. °C ----85±1				

Table 6. Bleaching of washed pulp of higher kappa no. from final stage of B.S.W. (after alkali leaching) under CEpHD sequences

Particulars	Screened washed pulp from final stage of B.S.W. Kappa No. 29.4 Expt. No. 1	Blank pulp (with out alkali treatment) Kappa No. 26.9 Expt. No. 2	Final washed pulp from B.S.W. treated with alkali	
			Kappa No. 25.6 Expt. No. 3	Kappa No. 25.3 Expt. No. 4
Chlorination stage				
i) Cl_2 applied/consumed, %	5.9/5.8	5.4/5.2	5.0/4.6	5.0/4.6
ii) End pH	2.5	2.5	2.3	2.3
Alkali extraction stage				
i) NaOH applied, %	2.35	2.15	2.0	2.0
ii) H_2O_2 applied, %	0.4	0.4	0.4	0.4
iii) End pH	10.3	10.7	10.9	11.0
Calcium hypochlorite stage				
i) Hypochlorite applied/ consumped, % as available Cl_2)	3.9/3.6	3.6/3.3	3.4/2.9	3.45/2.9
ii) Sulphamic acid, %	0.1	0.1	0.1	0.1
iii) Buffer added, %	1.0	0.9	0.8	0.8
iv) End pH	8.2	8.3	8.3	8.5
Chlorine dioxide stage				
i) ClO_2 applied/consumed, %	0.6/0.53	0.6/0.51	0.6/0.51	0.6/0.50
ii) End pH	7.0	6.7	6.5	6.4
Final Results				
i) Total Cl_2 applied/ consumed, %	9.8/9.4	9.0/8.5	8.4/7.5	8.45/7.5
ii) Total ClO_2 applied/ consumped, %	0.6/0.53	0.6/0.51	0.6/0.51	0.6/0.50
iii) Pulp brightness, % P.V.	88.0	88.0	88.0	88.0
iv) Pulp viscosity, (0.5% CED, Cps)	6.6	7.1	8.0	7.5
v) P.C. No.	2.8	2.4	1.7	1.6
Constant bleaching conditions				
	C	**E**	**H**	**D**
Consistency %	3.0	10.0	10.0	10.0
Temp. °C	Room	60±1	40±1	70±1
Time, mts.	60	60	120	120

Washed and screened pulp from final stage of B.S.W having 29.4 Kappa, blank experiment pulp of 26.9 Kappa, 2% NaOH treated pulp of 25.1 Kappa and 3% NaOH treated pulp of 25.3 Kappa were bleached under CEpHD sequence to achieve pulp brightness 87±1% P.V. Bleaching conditions and results are recorded in Table 6. Bleached pulps were beaten to 30°SR freeness. The physical strength properties of bleached pulps are recorded in Table 7.

RESULTS AND DISCUSSION

Unbleached pulp from final washer of 25.3 Kappa was treated with 2.0%, 3.0% and 4.0% NaOH at 60°C, 75°C and 85°C in different sets of experiments. The delignification experiments were performed at 10% pulp consistency and 60 minutes reaction time to simulate the delignification conditions at plant level. Effect of temperature variation on kappa no of final washed B.S.W pulp with respect to alkali dosage variation is shown in Fig. 1. Pulp washing at higher temperature in the range 70°C to 90°C is advantageous to reduce chemical losses, hence the temperature range between 60°C to 85°C was chosen for laboratory delignification/leaching experiments. At 60°C and 75°C the reduction in kappa no was more or less same but at 85°C reduction in Kappa No. was on higher side Table 1.

Unbleached pulp from final washer without screening had 26.3 Kappa and after screening it was 22.6 with rejects 0.58%. Without alkali treatment to the pulp but giving retention time of 60 minutes at temperature 85°C and maintaining pulp consistency 10%, the screened pulp kappa no was reduced to 20.4. After addition of alkali dosages 2%, 3% and 4% the Kappa No. of screened final washed pulp from B.S.W was reduced to 19.0, 18.0 and 17.8 respectively. The effect of caustic dosage variation on Kappa No. of final washed pulp is projected in Fig. 2. There was marginal reduction in Kappa No. after alkali treatment (Table 2) and the end pH was increased with increase in NaOH dosages. As may be seen under the delignification conditions Kappa No. could be reduced 5 to 5 degrees compared to screened B.S.W pulp.

Washed pulp from third washer and its delignified pulps were bleached under CEpHD sequence to achieve 87± 1P.V% brightness. It was observed that the bleached pulp of blank experiment had higher pulp viscosity than screened pulp (Table 3) for same brightness. The viscosity of 2% NaOH delignified bleached pulp was higher either to 3% alkali delignified bleached pulp or blank

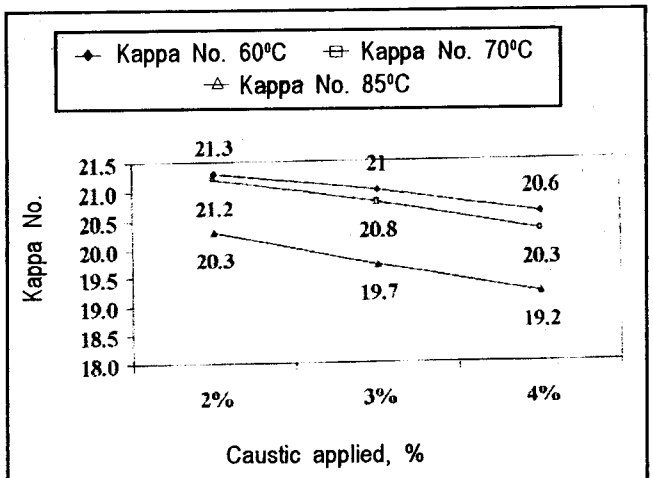

Fig. 1 Effect of temperature variation on Kappa No. of final washed B.S.W pulp w.r.t. alkali dosage variation.

Table 7. Physical strength properties of final washed pulp from B.S.W (alkali treated) higher kappa No. bleached pulp

Particular	Final washed pulp from B.S.W., (alkali treated) higher Kappa No. bleached pulp			
	Expt. No. 1	Expt. No. 2	Expt. No. 3	Expt. No. 4
Initial Freeness, °SR of pulp	14	14	14	14
Number of beating revolution in P.F.I. Mill	3800	4000	4100	3500
Initial Freeness, °SR of pulp	30	30	29	29
Bulk, c.c./gram	1.42	1.41	1.41	1.40
Tensile Index, N.m/g	55.55	59.58	62.30	60.41
Burst Index, K.Pa.m²/g	3.92	4.1	4.44	4.2
Tear Index, N.m²/g	6.53	6.86	7.51	7.15
Double fold	185	238	374	268

experiment bleached pulp. About 20% chlorine could be saved when 2% alkali delignified pulp was bleached under CEpHD sequence compared to final screened bleached pulp. The effect of lowering kappa no of washed B.S.W pulp with/without alkali leaching on chlorine application is depicted in Fig. 3.

Physical strength properties of bleached pulp from final screened washed pulp from B.S.W are lower than blank experiment whereas 2% alkali delignified bleached pulp has higher strength properties than either blank experiment or 3% alkali delignified bleached pulp (Table 4). Effect of lowering of kappa no of final B.S.W washed pulp with/without alkali leaching on bleached pulp strength properties is shown in Fig. 4.

Unscreened washed pulp from final stage of B.S.W was selected for delignification and had 31.6 kappa and after screening it was 29.4 with rejects of 1.5%. The screened pulp without alkali treatment but retention time of 60 minutes at 85°C had reduced from kappa no 29.4 to 26.9. The end pH was 10.7, 11.1 and 11.6 respectively. The screened rejects after alkali treatment was marginally reduced. It is evident that after alkali treatment of washed and screened B.S.W pulp, the kappa no could be reduced by four degree (Table 5). The effect of caustic dosage variation on kappa no reduction of final washed pulp is depicted in Fig. 5.

Washed pulps of B.S.W after screening and delignification were bleached under CEpHD sequence to achieve 87±1% P.V pulp brightness. The bleached pulp in blank experiment has higher viscosity as compared to screened bleached pulp.

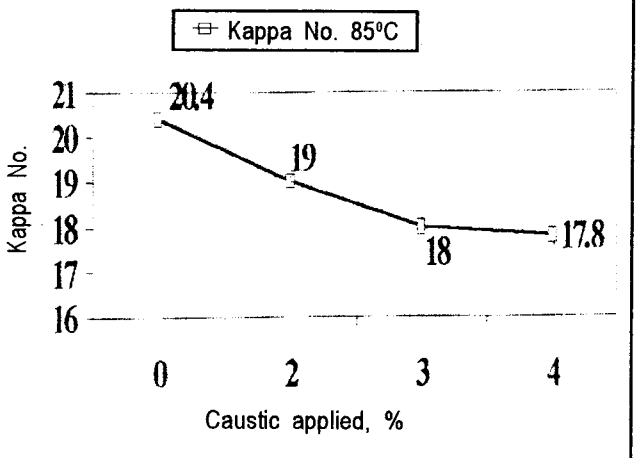

Fig. 2 Effect of caustic dosage variation on lower Kappa No. of final washed B.S. W pulp.

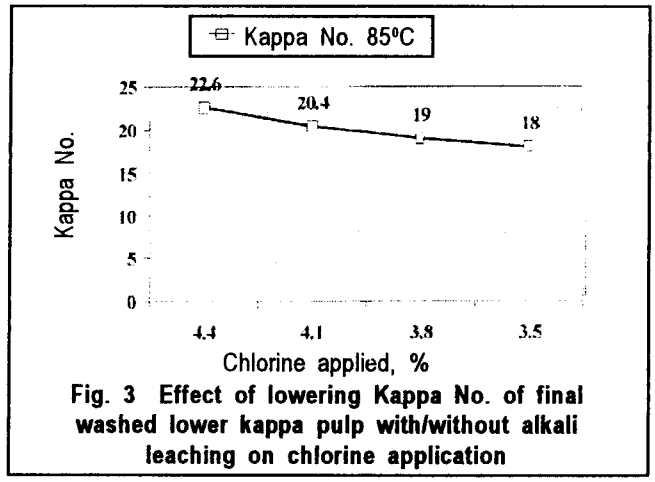

Fig. 3 Effect of lowering Kappa No. of final washed lower kappa pulp with/without alkali leaching on chlorine application

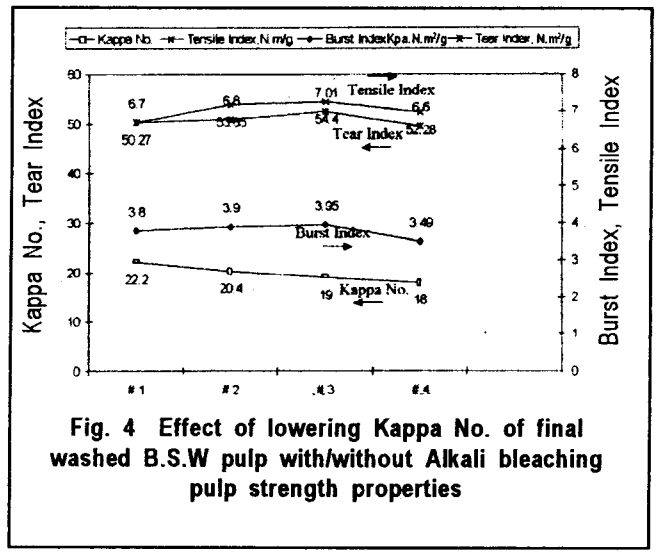

Fig. 4 Effect of lowering Kappa No. of final washed B.S.W pulp with/without Alkali bleaching pulp strength properties

Delignified pulp with 2% alkali and its bleached pulp has higher pulp viscosity than either 3.0% alkali treated bleached pulp or the blank bleached pulp (Table 6). The effect of lowering kappa no of final washed pulp with/without alkali leaching on first chlorine application % is projected in Fig. 6. Around 15% chlorine was reduced when 2% alkali treated pulp was bleached under CEpHD sequence and compared the results with blank experiment. The P.C No of alkali delignified bleached pulp is lower either to screened or blank bleached pulps.

Delignified washed pulp from final B.S.W (higher kappa no) bleached pulps were evaluated for physical strength properties at 30°SR freeness and the results are reported in Table 7. It shows that 2% alkali delignified bleached pulp has higher strength properties than screened, blank and 3% alkali delignified bleached pulps as depicted in Fig. 7.

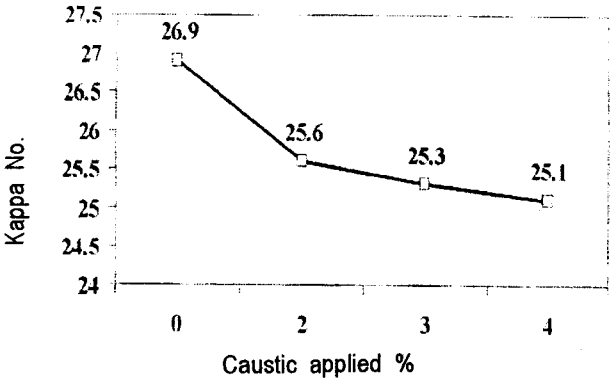

Fig. 5 Effect of caustic dosage variation on higher Kappa no. of final washed B.S.W pulp

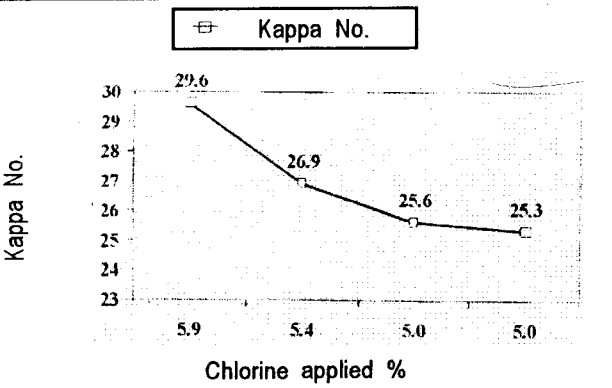

Fig. 6 Effect of lowering Kappa No. of final washed pulp with/without alkali leaching on chlorine application

CONCLUSION

2% alkali treatment of washed pulp from the final stage B.S.W (lower and higher kappa nos) at 85°C for 60 minutes duration and at 10% consistency reduced the Kappa No. of the pulp by 4 to 5 degrees. It helped in lowering chlorine consumption by 15-20% to achieve the pulp brightness 87±1%

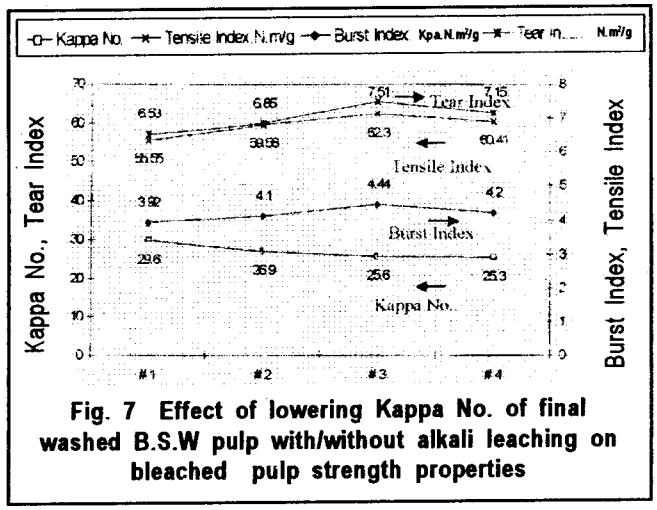

Fig. 7 Effect of lowering Kappa No. of final washed B.S.W pulp with/without alkali leaching on bleached pulp strength properties

P.V. The physical strength properties of 2% alkali treated pulp bleached pulps under CEpHD sequence are higher than screened and washed pulp from B.S.W blank experiment and 3% alkali treated bleached pulps.

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