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Improving the Shade of Kraft Paper

The kraft paper produced from bamboo has good shade to suit the market specifications. Because of the shortage of bamboo raw material, local hardwoods are being used along with bamboo to meet the demand of paper. Owing to the use of mixed hardwoods to the extent of 30 to 40% difficulties were experienced in maintaining the desired shade of kraft paper. So, laboratory investigations were carried out to brighten the shade of the pulp without impairing the pulp yield and the strength properties of paper. Due to the easy availability, low cost, easy handling, etc. calcium hypochlorite was selected as a brightening agent in the present work. The kraft pulp blends of bamboo, eucalyptus, mixed hardwoods and pine wood were treated with varying amounts of calcium hypochlorite. The treated pulp had a brighter shade. By adjusting the dosage of calcium hypochlorite the kraft pulp of darker shade could be made as bright as desired. The pulp shrinkage, due to the treatment, was negligible and the strength properties were slightly better except tear which was low. In the plant-scale trials it was possible to maintain the bright shade of the kraft paper by adding the required quantity of calcium hypochlorite solution to the unbleached pulps of any dark shade. Since, there was no need of washing the pulp after the addition of calcium hypochlorite solution, the whole procedure of treatment was simple and quick. The kraft paper made from this pulp was characterised by uniform bright shade and improved strength properties. There were no adverse effects in processing this pulp in the paper machine. In fact, the incidence of slime in the stock in the paper machine was noticeably reduced.

INTRODUCTION

The kraft paper produced from bamboo varieties is having good shade and has good market response. Because of the shortage of bamboo, hardwoods individually or in admixture are being increasingly used along with bamboo to meet the growing demand of more paper. Some of the known colouring agents in wood belong to the catechins, flavonols, naphto-quinones, xanthones and anthocynins. The colouring matter in wood is partially removed in pulping but some colouring matters remain with the pulp. These are responsible for the darkening of pulp which occurs on exposure to air[1]. Except few, most of the hardwoods give darker shade to unbleached kraft pulp whereby the kraft paper produced of this pulp blend has a darker shade. As there is a demand for brighter kraft paper in the market, experiments were carried out in the Research Centre to study the variations of the shade of the kraft pulp[2]. It was observed that from brightness point of view, in the decreasing order, the raw materials available, can be arranged as follows :

Eucalyptus > Bamboo > Mixed hardwoods. It was also observed that variables like Kappa Number and long delayed blows, etc., were responsible for darker pulp shade. It was found that eucalyptus which is being used for pulping along with bamboo produces unbleached pulp of light shade while the local mixed hardwoods produce unbleached pulp of very dark shade. The effect of age and the condition of raw material are also contributing to the development of shade of unbleached

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pulp. Sound (fresh) bamboo was observed to produce comparatively pale coloured unbleached pulp while old and decade bamboo produces dark to very dark coloured unbleached pulp. The unbleached pulp becomes very dark if the digester blow is too much delayed. This is because of the redeposition of lignin if the residual active alkali is lower than a minimum. The pulp of higher Kappa Number of a particular raw material was darker in shade than the one of lower kappa Number. Because of these day to day variations in the plant it is rather difficult to maintain the shade of the unbleached pulp and that of the kraft paper manufactured.

In the literature the use of some chemicals has been described to improve the shade of pulp. Cochrane[3] observed that sodium sulphite added in grinder shower water can increase grinder pulp production and reduce power consumption, besides increasing the brightness of mechanical pulp. 0.8 to 1.0% addition of sodium sulphite increases pulp brightness by 2-3 G.E. units and newspaper brightness by 1.5—2.0 G.E. units. Brightness increases obtained with hydrosulphites are normally to a few points with kraft. Sodium hydrosulphite gave 3.5 to 5.3 points of improvements at levels of 4 to 8 Kg per tonne of pulp[4]. High yield calcium base pulps from western hemlock increased brightness from an original brightness of 46 G.E. units by 4.6 units with 0.1% borohydride and 6 units with 0.2 and 0.5% treatment[5]. For high yield pulps which include groundwood and cold soda pulp hydrogen peroxide in the range of 0.5 to 1.5% on pulp basis is successfully being used for brightening the pulp to 10 or more G.E. units with low yield losses and excellent brightness stability (6).

Although the above mentioned brightening agents are useful for this purpose they are not economically suitable because of their cost, availability and handling problems etc. So it was decided to conduct experiments using calcium hypochlorite for improving the shade of the pulp without impairing the yield and strength characteristics. Reasons for selecting calcium hypochlorite to use as a brightnening agent are its easy availability, low cost. effectiveness even at room temperature, easy handling etc.

Experimental

The following raw materials were used for the experiments.

1. Bamboo medar (Dendrocalamus strictus)
2. Eucalyptus (Eucalyptus hybrid)
3. Mixed hardwoods (mixed in equal proportions).
   i) Nandi (Lagerstroemia lanceolata).
   ii) Dhaman (Grewia tiliaefolia)
   iii) Dindal (Anogeissus latifolia)
   iv) Bhendi (Kydia calycina)
   v) Heddi (Adina cordifolia)
   vi) Kalam (Mitragyna parviflora)
   vii) Ghoting (Terminalia belerica)
4. Pine wood (from North India).

Mixtures of chips of the above raw materials were taken in the following order and chips classification are given tn Table No. I.

1) Bamboo 80% + Eucalyptus hybrid 20%.
2) Mixed hardwoods 100%
3) Mixed hardwoods 70%+ Pine wood 30%.

Table No. I—Chips Classification

Screen used	Bamboo 80% + Eucalyptus hybrid 20%	Mixed hardwoods 100%	Mixed hardwoods 70% + Pine wood 30%
	%	%	%
Retained on 32 mm	Nil	Nil	Nil
-32 mm to + 25 mm	21.2	15.2	15.8
-25 mm to + 22 mm	12.9	8.8	12.1
-22 mm to + 19 mm	13.5	12.5	12.7
-19 mm to + 16 mm	17.3	14.8	16.2
-16 mm to + 13 mm	14.5	15.1	15.5
-13 mm to + 6 mm	17.6	27.0	23.6
Passing through 6 mm	3.2	6.8	4.2

The pulping of above chips was separately carried out in a electrically heated rotary digester of 16 litres capacity using white liquor of 20% sulphidity. After washing the pulp, pulp yield, Kappa Number, brightness were determined and are recorded in Table No. II.

Two series of treatments with calcium hypochlorite were conducted as follows:

Furnish A

Bamboo + Eucalyptus 70% + Mixed hardwoods 30%. 0, 2, 3, 4, 5 and 6 percent calcium hypochlorite as available chlorine were added to the pulp furnishes.

Furnish B

Bamboo + Eucalyptus 70% + Mixed hardwoods + Pine wood 30%. 0, 2, 3, 4 and 5 percent hypochlorite solution on available chlorine basis was added to the pulp furnishes.

The constant conditions maintained were as under:

1. Charge—360 g. pulp on oven dry basis.
2. Pulp Consistency—5 percent
3. Temperature—35°C.
4. Reaction time--to the exhaustion of available chlorine.

The conditions of the treatment, Kappa Number, brightness, relative brightness Ry (Absolute black 0 and perfect white 100), and pulp shrinkage are recorded in Table No. III. The above hypochlorite treated unwashed pulps were beaten in the laboratory Valley beater to slowness levels of 20, 30 and 40° SR. Standard handsheets were made on British Sheetmaking Machine and tested for strength properties and ash content as per Tappi procedure. The results are recorded in Table No. IV (a) and (b). Results of Table No. III are plotted in Fig. Nos. 1 and 2 and the results of Table No. IV (a) and IV (b) are plotted in Fig. Nos. 3 and 4 for 33°SR level in each case.

Table No. II

Pulping data

Cooking conditions	Bamboo 80% + Eucalyptus hybrid 20%	Mixed-hardwoods 100%	Mixed hardwoods 70% + Pine wood 30%
Chemicals as Na_2O% on chips	17	19.5	21
Bath ratio, W:Liq.	1:2.7	1:2.7	1:2.7
Temp. & Time			
70–120°C., Min.	45	45	45
At 120°C., Min.	60	60	60
120—170°C., Min.	90	90	90
At 170°C., Min.	45	90	90
H factor	995	1700	1700
Unbleached pulp yield % (screened)	51.7	41.8	38.5
Rejects, %	0.6	0.9	0.8
Kappa No.	23.0	33.0	31.3
Brightness, %	26.3	16.2	18.3
Residual A.A. as Na_2O, gpl (17°Tw at 80°C.)	7.6	6.8	9.3

Note: Weak black liquor was used as makeup water in the digester.

Discussion

From this experimental work it is evident that both the furnishes gave the same trend of brightening the shade of unbleached pulp as well as strength properties.

Though calcium hypochlorite solution was added from 0 to 6% to Furnish A and 0 to 5% to Furnish B, untreated unbleached pulp of 23% brightness was brightened to an acceptable shade level of 32% brightness by mere 3% addition of calcium hypochlorite. However, further additions were continued for experimental studies.

The following observations were made when calcium hypochlorite was added from 0 to 3% as available chlorine to the pnlp.

Furnish A

(1) Reaction time was increased from 0 to 12 minutes.

Table No. III
Effect of calcium hypochlorite addition on unbleached pulp

	FURNISH A						FURNISH B				
Set No.	1	2	3	4	5	6	1	2	3	4	5
(1) Calcium hypochlorite added on pulp % as Cl_2	0	2	3	4	5	6	0	2	3	4	5
(2) Reaction Time, Minutes	0	7	12	25	40	55	0	5	10	14	27
(3) pH at the end	8.1	7.7	7.4	6.8	6.5	6.4	8.3	8.0	7.6	7.2	7.0
(4) Shrinkage, %	Nil	0.5	0.8	1.0	1.8	2.5	Nil	0.6	0 8	1.0	1.4
(5) Kappa Number	26.0	21.2	16.2	10.5	8.9	7.0	25.8	20.8	17.2	14.2	9.9
(6) Brightness, % (Elrepho)	23.3	28.7	32.4	41.6	47.3	50.2	23.9	27.7	32.3	36.0	45.0
(7) Relative brightness, Ry (Elrepho)	31.6	41.3	46.5	58.9	64.5	66.1	32.4	39.4	46.2	51.7	61.9

FURNISH A—Bamboo+Eucalyptus hybrid 70%+Mixed Hardwoods 30%
FURNISH B—Bamboo+Eucalyptus hybrid 70%+Mixed Hardwoods+Pine wood 30%.

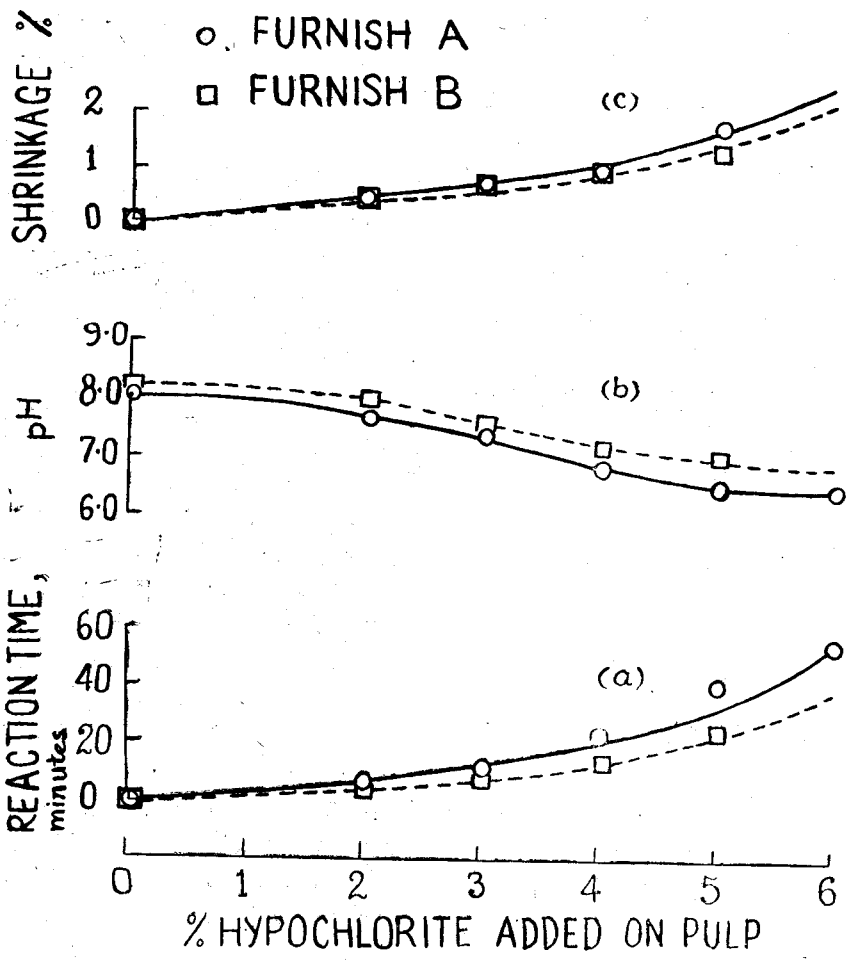

Fig. No. 1–Effect of calciumhypochlorite addition on (a) Reaction time (b) pH and (c) Shrinkage of unbleached kraft pulp.

(2) pH drop was from 8 1 to 7.4.
(3) Pulp shrinkage was from 0 to 0.8%.
(4) Kappa Number was lowered from 26.0 to 16.2.
(5) Brightness was increased from 23.3% to 32.3%.
(6) Relative brightness, Ry was increased from 31.6% to 46.5%.

Furnish B

(1) Reaction time was increased from 0 to 10 minutes.
(2) pH drop was from 8.3 to 7.6.
(3) Pulp shrinkage was increased from 0 to 0.8%.
(4) Kappa Number was lowered from 25.8 to 17.4.
(5) Brightness was increased from 23.9% to 32.3%.
(6) Relative brightness, Ry was increased from 32.4% to 46.2%.

The relative brightness test (Elrepho) using filter no. 10 is suitable for the comparison of

Table No. IV (a)

FURNISH A — **Strength properties of unbleached pulp**

Calcium hypochlorite added, %	0			2			3			4			5			6		
Particulars	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3
Initial freeness, °SR	17	17	17	18	18	18	18	18	18	18	18	18	18	18	18	18	18	18
Final freeness, °SR	21	32	42	20	30	39	20	29	39	20	28	38	19	30	38	19	30	43
Beating time, Mins.	2	9	13	2	10	14	1	8	13	1	8	15	1	9	15	1	8	15
*Drainage time, Secs.	4 8	5.3	7.0	4.7	5.5	6.5	5.0	6.0	6.7	4.6	5.7	7.4	4.6	5.5	6.5	4.5	5.4	8.2
Basis wt., g/m²	59.5	59.6	62.2	57.5	60.2	58.2	61 0	60.2	60.2	60.2	58.0	59.4	58.2	63.3	61.0	59.6	61.4	59.7
Bulk, cc/g.	2.06	1.85	1.60	2.04	1.79	1 65	1.98	1.73	1.54	1.95	1.75	1.57	2.01	1.71	1.53	2.02	1.72	1.57
Burst factor	34.8	47.6	48.8	32.8	50.2	53.2	34.0	50.0	56.5	33.2	48.5	56.4	33.7	49.0	56.4	30.4	47.7	54.6
Breaking length, km.	4.15	6.0	6.25	4.18	6.44	6.95	4.25	6.36	7.35	4.4	6.4	6.9	4.35	6.45	7.26	3.94	6.4	7.65
Stretch, %	1.9	2.3	2.5	1.9	2 5	2.8	2.3	2 8	3.1	1.9	2.5	2.7	1.9	2.7	3.1	1.8	2.6	2.9
Tear factor	84.6	80.5	70.2	86.4	81.0	73.0	86.6	78.0	74.5	83.7	79.4	74.8	86.8	7.45	70.8	85.6	76.9	71.8
Folding endurance, DFs. (MIT)	7	28	54	7	35	64	9	57	174	9	48	77	7	51	123	7	47	142
Ash in paper on O. D.	1.65			1.63			1.57			1.57			1.58			1.4		
Strength Index Number		1770			1850			1900			1865			1840			1825	

Sheet mould — FURNISH A—Bamboo + Eucalyptus hybrid 70% + Mixed hardwoods 30%.

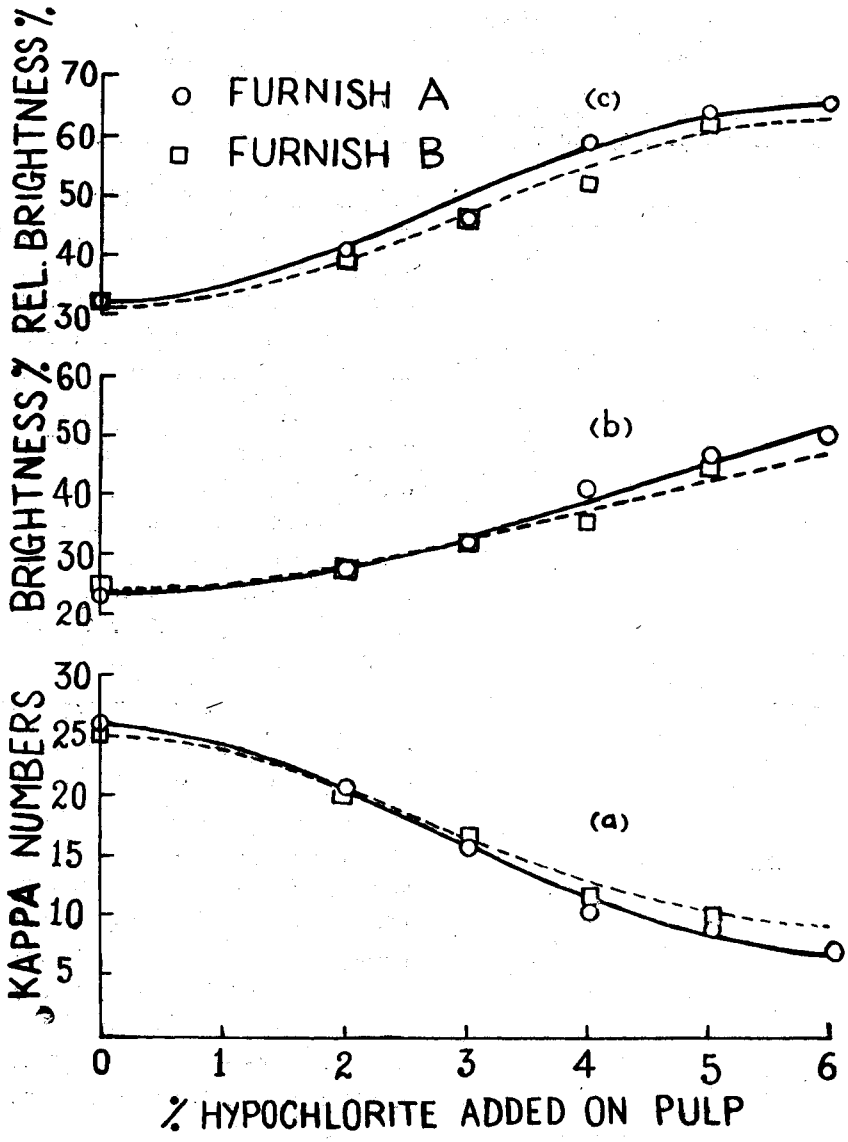

Fig. No. 2–Effect of calcium hypochlorite addition on (a) Kappa number (b) Brightness and (c) Relative Brightness of unbleached kraft pulp

shades of unbleached pulp or paper rather than the routine test of brightness using filter no. 8. Because in the routine test of brightness, results are given only in blue region of wave length 457 m/u, while the relative brightness is indicated directly by the value of Y on a scale that represents on absolute black as 0 and a perfect white was 100 (7).

The strength properties like burst stretch, breaking length and folding endurance of the treated pulps in both the furnishes were found better than those of the untreated unbleached pulps. Bulk remained almost the same. Tear factor was decreased to some extent. Strength Index number– (Burst factor x Tear factor x log double folds) 100 were improved after hypochlorite addition. There was no appreciable change in ash content in paper by the addition of calcium hypochlorite.

Milton H. Voelker and Malcolm N. May[8] had carried out experiments to study the effects produced by drying an unbleached kraft pulp prior to a single stage

Table No. IV (b)

Strength properties of unbleached pulp

FURNISH B															
Hypo added %	0			2			3			4			5		
Particulars	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3
Initial freeness, °SR	17	17	17	17	17	17	17	17	17	18	18	18	18	18	18
Final freeness, °SR	20	30	40	22	32	41	19	29	39	20	29	39	20	30	41
Beating time, Mins.	2	9	13	2	9	14	1	8	13	2	9	13	2	9	14
Drainage time*, Secs.	4.5	5.8	6.7	4.5	6.0	6.8	4.5	5.8	6.8	4.5	5.2	7.0	4.5	6.2	6.9
Basis wt., g/m²	60.0	51.5	59.8	60.0	61.0	58.5	57.6	62.6	62.0	59.2	59.8	57.8	61.0	58.9	58.2
Bulk, cc/g.	1.91	1.71	1 66	1.95	1.79	1.69	1.99	1.72	1.61	1.91	1.78	1.59	1.84	1.66	1.63
Burst factor	38.0	46.5	51.0	33.4	49.6	52.0	33.0	48.8	57.0	32.0	49.0	56.6	34.8	48.5	55.3
Breaking length, km	4.52	5.7	6.5	4.55	6.56	6.85	4.16	6.17	6.9	4.05	6.25	6.95	4.05	5.60	6.65
Stretch, %	2.0	2.3	2.6	2.0	2.5	2.7	2.0	2.5	2.7	1.9	2.6	2.9	2.0	2.2	2.6
Tear factor	91.2	84.0	79.0	87.0	82.0	75.0	90.2	78 0	73.0	84.5	78.4	72.6	86.5	74.8	72.2
Folding endurance DFs. (MIT)	13	40	77	9	49	87	8	54	118	9	35	111	11	48	166
Ash in paper on OD	1.33			1.32			1.30						1.32		
Strength Index No		1843			1900			1875			1700			1830	

*Sheet mould FURNISH B—Bamboo+Eucalyptus hybrid 70%+Mixed hardwoods+Pine wood 30%.

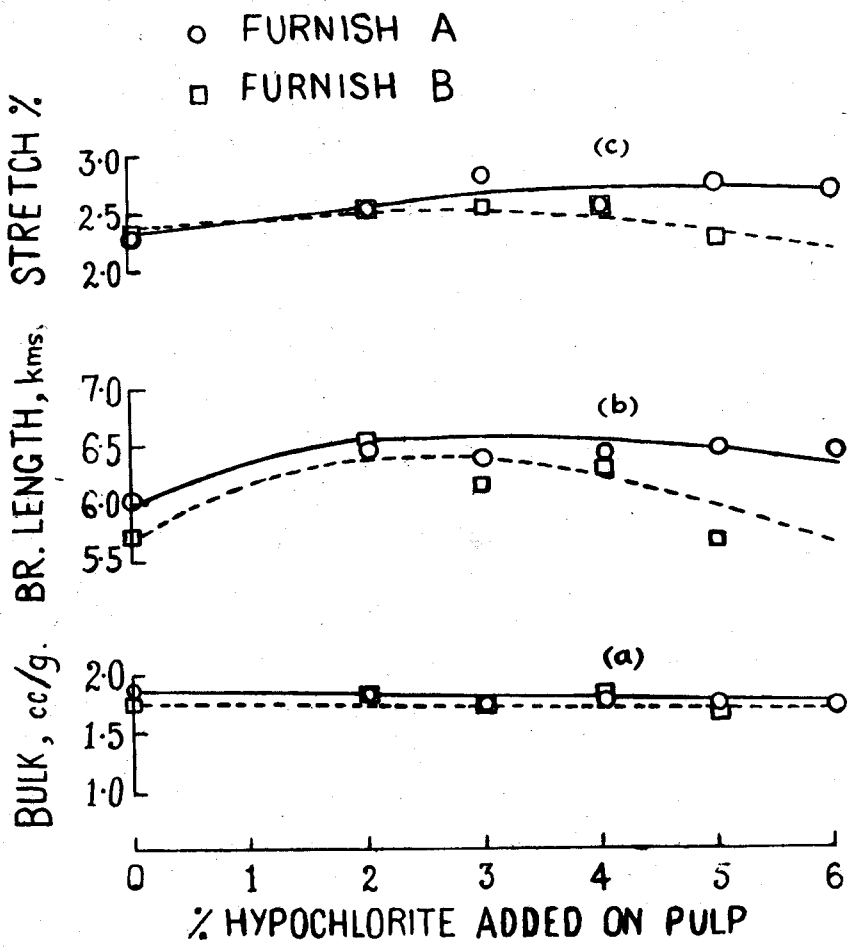

Fig. No. 3–Effect of calciumhypochlorite addition on (a) Bulk (b) Breaking length and (c) Stretch of unbleached kraft pulp

calcium hypochlorite bleaching treatment. There also shrinkage observed was very low, burst, and breaking length were improved and tear factor was lowered slightly after small dosage of calcium hypochlorite on pulp.

So, it is observed that most of the colouring matters responsible for the dark shade can be conveniently removed by mild calcium hypochlorite treatment to obtain the required bright shade of the kraft paper.

Based on the laboratory experimental work, plant trials were conducted to improve the shade of unbleached kraft pulp by adding 1.7 to 2.1% calcium hypochlorite on available chlorine basis. The results obtained in plant trials were very encouraging as it was possible to reduce fluctuations in the shades of the kraft paper in the mill. Moreover, the treatment is quite simple as

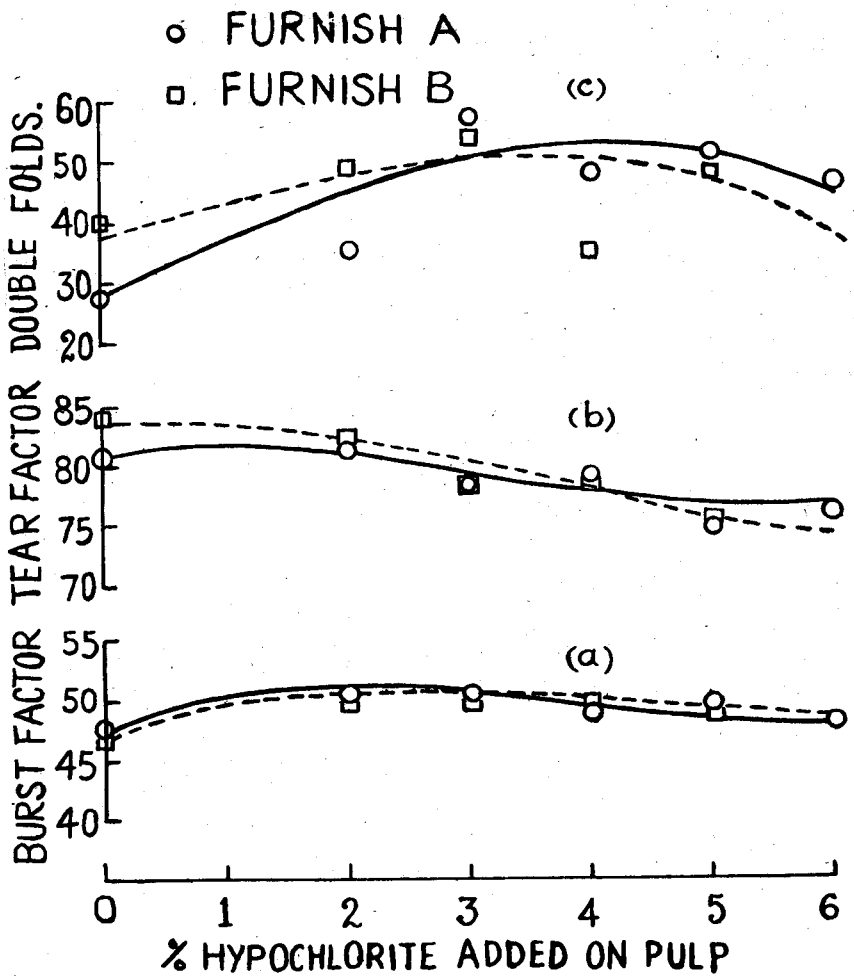

Fig. No. 4–Effect of calciumhypochlorite addition on (a) Burst factor (b) Tear factor and (c) Double folds of unbleached kraft pulp

addition is based on the comparison of shade of pulp with that of standard shade card. No heating, washing or separate equipment is necessary for improving the shade of unbleached pulp. The brightening effect is also quick. While processing the calcium hypochlorite treated pulp, incidence of slime in the stock was noticeably reduced. Hence, the periodical cleaning of machine parts and use of slimicides were appreciably reduced. Thus calcium hypochlorite acted as slimicide besides a brightening agent. No adverse effects of calcium hypochlorite addition to unbleached pulp were observed in the paper.

Conclusions :

For maintaining uniform shade of kraft paper calcium hypochlorite is found a suitable brightening agent. By mild treatments using 1 to 3% calcium hypochlorite, it was possible to remove most of the colouring matters to get the required bright shade of kraft paper. The kraft paper made from treated pulp was characterised by uniform shade, improved strength properties, etc. There was noticeable reduction of slime in the stock and this improved the runnability of paper machine. No. adverse effects were observed in processing the treated pulp in the paper machine.

From the above study kraft paper of desired bright shade could be manufactured from pulps of different blends having dark shade

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