

# Effect of Urea as Inhibitor in Bleaching

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## SUMMARY

The effect of urea as inhibitor in different stages of bleaching was studied. Fibre Strength Index and Intrinsic Viscosity were taken as indicative parameters for pulp strength properties. 0.1% Urea in chlorination improves pulp properties with slight reduction in brightness. With 0.5% Urea there is no further improvement in pulp properties where as there is significant drop in brightness. 0.1% Urea addition in hypo stage results in a slight reduction in brightness with improvement in pulp properties. In comparison, 0.1% Sulfamic acid improves pulp viscosity to a greater extent than 0.1% Urea with similar slight drop in brightness. Both are not effective in improving the brightness stability. It should be borne in mind that the cost of commercial urea is about 4 to 5 times cheaper than that of commercial sulfamic acid.

Lot of work has already been carried out on Sulfamic acid in chlorination and hypochlorite stages for improving viscosity and strength properties<sup>1,2,3</sup> but only limited work was carried out on the effect of urea in chlorination and hypochlorite stages of bleaching<sup>4</sup>. Preliminary studies were undertaken to evaluate the influence of urea as an inhibitor in different stages of bleaching. For these studies, bamboo (*Dendrocalamus strictus*) from Bastar area was taken. The optimum pulping conditions and results are given in Table 1. The pulp of kappa number 27.2 was taken for bleaching studies.

## EXPERIMENTAL

**Kappa Number :** Kappa number determination was carried out according to standard TAPPI method T-236-0S-76.

**Viscosity :** The intrinsic viscosity determination was carried out in cupriethylene diamine (CED) solution according to SCAN-C 15 : 62 method.

**Brightness :** Brightness was determined according to ISO standard 2470.

**Post color number :** Brightness was measured after keeping the brightness sheet in a forced circulation oven at 105°C for four hours. Initial brightness was also measured.

$$P. C. Number = 100 \times \frac{(1 - R_{\alpha_2})^2}{2 R_{\alpha_2}} - \frac{(1 - R_{\alpha_1})^2}{2 R_{\alpha_1}}$$

$R_{\alpha_1}$  = diffuse reflectance factor before aging.

$R_{\alpha_2}$  = diffuse reflectance factor after aging.

**Fibre Strength Index :** Fibre Strength Index was determined using the Pulmac Zero Span Tester as detailed in<sup>5</sup>.

TABLE—1 KRAFT PULPING OF BAMBOO (*DENDROCALAMUS STRICTUS*)

Chemical as Na <sub>2</sub> O	%	=	16.0
Sulfidity	%	=	25.0
Chips to liquor ratio		=	1:3
Cooking temperature °C		=	170
<b>Cooking Schedule :</b>			
To 100°C min.		=	30
From 100°C to 120°C min.		=	30
at 120°C min.		=	45
From 120°C to 170°C min.		=	75
at 170°C min.		=	90
H factor		=	1660
Total yield %		=	47.6
Screen rejects %		=	0.1
Kappa number		=	27.2
<b>Black liquor :</b>			
Total solids % w/w		=	19.5
Residual active alkali as Na <sub>2</sub> O g/l		=	8.34
(at 200, g/l total solids)			

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## RESULT AND DISCUSSION

### EFFECT OF UREA IN CHLORINATION

Optimum dosage in chlorination under normal conditions was found out using different chlorine(%) dosages and plotting residual chlorine in mg/l against chlorine applied and the chlorine dosage corresponding to the point of intersection was taken as the optimum dosage. The optimum chlorine dosage was found to be 6.2%. For finding out the effect of urea in chlorination, experiments were carried out on small scale using 20 gm. OD pulp, utilising Plackett and Burman statistical design<sup>6</sup> and the following variables were studied within the limits mentioned below for their influence on pulp properties like fibre strength index, intrinsic viscosity, brightness etc.

Variable	Max. limit	Minimum limit
Chlorine dosage %	7.2	5.2
Temperature °C	50	30
Time (min)	45	20
Urea %	0.5	0.1
Consistency was maintained at 3%.		

After chlorination pulp was treated with SO<sub>2</sub> water at pH 4 for 15 minutes. From the interpretation of the results (as detailed in<sup>6</sup>, increasing the urea addition from 0.1% to 0.5% has got negative effect on brightness and no significant effects on fibre strength index and viscosity of the pulps. Further experiments were carried out, to evaluate the influence of urea in chlorination and the results are given in Tables 3 and 4. From Table 3 it can be observed, that addition of 0.1% urea improves the intrinsic viscosity and fibre strength index, with a slight reduction in brightness. Increasing the urea dosage to 0.5% there is no significant improvement in pulp properties like intrinsic viscosity and fibre strength index but there is appreciable reduction in brightness. Addition of urea, increases the residual chlorine concentration. Almost similar trend is observed with urea addition in chlorination at higher temperature (50°C) (Table 4).

### EFFECT OF UREA IN HYPO STAGE

After chlorination and alkali extraction under optimum conditions, 2% hypochlorite as chlorine

TABLE 2 STUDY ON THE EFFECT OF UREA IN CHLORINATION

Sl. No.	Particulars	Pulp Brightness % ISO	Intrinsic Viscosity cm <sup>3</sup> /g	Fibre Strength Index Km.
1.	7.2% Cl <sub>2</sub> , 50°C 45 min. 0.1% Urea	26.5	856	14.1
2.	7.2% Cl <sub>2</sub> , 50°C 20 min. 0.5% Urea	23.4	871	15.1
3.	7.2% Cl <sub>2</sub> , 30°C 45 min. 0.1% Urea	25.2	935	15.1
4.	5.2% Cl <sub>2</sub> , 50°C 20 min. 0.1% Urea	21.1	960	14.0
5.	7.2% Cl <sub>2</sub> , 30°C 20 min. 0.5% Urea	22.8	867	14.0
6.	5.2% Cl <sub>2</sub> , 30°C 45 min. 0.5% Urea	21.4	937	14.6
7.	5.2% Cl <sub>2</sub> , 50°C 45 min. 0.5% Urea	21.9	942	13.7
8.	5.2% Cl <sub>2</sub> , 30°C 20 min. 0.1% Urea	20.6	953	14.9

TABLE-3 EFFECT OF UREA IN CHLORINATION AT 30°C

Sl. No.	Particulars	Final pH	Residual Chlorine mg/l	Brightness % ISO	Viscosity cm <sup>3</sup> /g	Fibre Strength Index km.
1.	6.2% Cl <sub>2</sub> , 3% Consistency 30 min.	1.9	49	27.7	895	13.8
2.	6.2% Cl <sub>2</sub> , 3% Consistency 30 min., 0.1% urea	1.9	61	26.3	954	14.4
3.	6.2% Cl <sub>2</sub> , 3% Consistency 30 min., 0.5% urea	1.9	147	23.5	944	15.0

was applied in hypo stage, to get a brightness of 73-75% ISO. The effect of urea in hypo stage was studied without using buffer. The results are given in Table 5. With 0.1% urea addition there is slight reduction in brightness (about 2 points) with improvement in pulp properties like viscosity and fibre strength index. Further increase in urea addition to 0.5%, results in drastic reduction in brightness with concomittant improvement in viscosity and fibre strength index. Urea addition interestingly increases the brightness reversion to some extent. At higher temperature (50°C) even addition of 0.1% urea reduces the brightness to a significant extent without any improvement in other pulp properties. With

0.5% urea addition, brightness is reduced from 73 to 58% ISO without significant improvement in pulp properties.

A comparison was made of the effect of urea with that of sulfamic acid in hypo stage and results are given in Table 6. Perusal of results shows, that the addition of 0.1% sulfamic acid results in a slight reduction in brightness (similar to that of 0.1% urea) with significant improvement in viscosity. Addition of 0.1% urea also improves viscosity but to a lesser extent than 0.1% sulfamic acid. In both cases, there is no improvement in brightness stability.

TABLE-4 EFFECT OF UREA IN CHLORINATION AT 50°C

Sl. No.	Particulars	Final pH	Residual Chlorine mg/l	Brightness % ISO	Viscosity cm <sup>3</sup> /g	Fibre Strength Index km.
1.	6.2% Cl <sub>2</sub> , 3% Consistency, 30 min.	1.6	7	26.7	937	14.2
2.	6.2% Cl <sub>2</sub> , 3% Consistency, 30 min, 0.1% urea	1.5	10	26.3	984	14.2
3.	6.2% Cl <sub>2</sub> , 3% Consistency, 30 min., 0.5% urea	1.4	36	24.7	981	14.6

TABLE-5 EFFECT OF UREA IN HYPOCHLORITE STAGE

Sl. No.	Particulars	Final p	Residual Chlorine mg/l	Bright-ness % ISO	Intrinsic Viscosity cm <sup>3</sup> /g	Fibre Stren-gth In-dex km.	Post Color Num-ber
8% Consistency 40°C, Without, buffer, 120 min.							
1.	C <sub>6.2</sub> E <sub>2.5</sub> H <sub>2</sub> O — blank	6.8	119	75.5	654	14.0	5.1
2.	—do— + 0.1% urea	6.8	11	73.0	694	14.8	6.1
3.	—do— + 0.5% urea	7.0	9	59.5	753	15.2	7.2
8% Consistency, 50°C with buffer, 120 min.							
4.	C <sub>6.2</sub> E <sub>2.5</sub> H <sub>2</sub> blank	9.0	6	73.2	626	15.0	4.0
5.	C <sub>6.2</sub> E <sub>2.5</sub> H <sub>2</sub> + 0.1% urea	9.0	9	66.7	632	14.0	4.3
6.	C <sub>6.2</sub> E <sub>2.5</sub> H <sub>2</sub> + 0.5% urea	9.3	11	57.8	715	14.0	5.2

TABLE—6 EFFECT OF UREA AND SULFAMIC ACID IN HYPOCHLORITE STAGE

Sl. No.	Particulars	Final pH	Residual Chlorine mg/l	Brightness % ISO	Intrinsic Viscosity cm <sup>3</sup> /g	Fibre Strength Index km.	Post Color Number
8% Consistency, 40°C, with buffer, 120 min.							
1.	C <sub>6.2</sub> E <sub>2.5</sub> H <sub>2</sub> blank	9.0	94	72.3	682	14.8	3.7
2.	—do— + 0.1% urea	9.0	11	69.2	714	14.8	3.8
3.	—do— + 0.1% sulfamic acid (NH <sub>4</sub> Salt)	9.0	77	69.3	777	14.6	3.8

## CONCLUSIONS

1. Use of 0.1% urea in chlorination improves the pulp properties with a slight reduction in brightness. Increase of urea addition to 0.5% results in no significant improvement in pulp properties but with appreciable reduction in brightness.
2. Addition of 0.1% urea in hypo stage reduces the brightness slightly with improvement in other pulp properties. Further increase to 0.5% results in drastic reduction in brightness with insignificant improvement in pulp properties. Addition of urea does not improve the brightness stability as evidenced by P.C. number.
3. In comparison, 0.1% sulfamic acid improves pulp properties to a greater extent than 0.1% urea, while the drop in brightness is of the same order.
4. The cost of commercial urea is around Rs. 2.50 per kg. as against the cost of commercial sulfamic which is around Rs. 10/- per kg.

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