Optimization of Bleaching Process to Achieve Pulp Brightness of 88+%ISO with Bamboo/ Hardwoods Furnish

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For Fully bleached high brightness pulp of ISO brightness > 88, every point brightness of pulp is important to get the full advantage in terms of quality and profitability. It is of paramount importance that pulp must be bleached to its full potential by optimizing the process conditions of individual bleaching stage and take full advantage of OWA at wet end.

A detailed study is presented for a bleaching sequence of CD EopHHD for a mix of bamboo/ Hardwood. The brightness at hypo stage preceding D-stage must be optimized to get full development of brightness in the final stage. Similarly, end pH of the D- Stage tower stock is an important factor. If the end pH at D- Stage is optimized for a given furnish, significant gain can be achieved in the final D-stage pulp.

For improved bleachability of pulp depending on the final product, the mills have to develop a strategy for the raw material sourcing so that the defined raw material mix will be available for better management of process parameters within the defined range.

INTRODUCTION

In the global scenario, the aesthetic value of any product has its own importance, as it is the parameter, which attracts the attention of any human being. Paper industry is no exception to this. The visual properties are equally important to that of functional properties and cost effectiveness of the product. Along with the colour coordinate, brightness is an important parameter for white printing papers or office stationary, which is essential in the market of top leading segment.

For a given bleached pulp brightness, there are various options to improve brightness of paper such as use of high brightness fillers, use of optical whitening agents at wet end as well as in size press, sizing of paper with less alum/ PAC. But the development of brightness in paper after certain limit becomes difficult and the only way remains is to improve basic pulp brightness.

European mills have raised the brightness through improvement in pulp basic brightness by adopting best of pulping and bleaching technologies. Due to higher brightness pulp; they are able to take fullest advantage of other additives such as optical whiteners in terms of performance and cost. But Indian mills are still using the conventional bleaching sequences with chlorine, oxidative caustic extraction, hypochlorite and chlorine di Oxide.

The performance of bleaching process depends on the conditions of individual process as well as bleaching response of different species used in the furnish. The fibrous raw material required for the process is continuously changing depending on the government policies and market wood availability, pricing and most of the paper maker has limited option of selecting raw material as per requirement.

Optimizing the process conditions suitable for the selected fibrous raw material can develop better pulp brightness, provided the basic requirement of bleaching such as adequate retention time, proper washing of each stage etc is carried out.

This paper will discuss the bench scale evaluation and practical experience of developing pulp brightness with different raw material furnish.

Pulp Basic brightness and OWA performance

In the present situation, one of the ways for the papermaker to raise the paper brightness is the use of optical whitening agents either at wet end or at size press. But the performance of the optical whitening agents for developing fluorescence brightness depends on the followings

Basic Pulp Brightness

Point of addition

Nature of the functional additives in the vicinity of the OBA addition etc.

The last two-points can be controlled depending on the process and machine conditions, but basic pulp brightness is essential to get the maximum benefits. Mill has conducted bench scale evaluation with the plant final bleached pulp of different pulp brightness for different dosages of optical whitening agents. The Fig-1 shows the performance of OWA at different brightness at different dosages of optical whitening agents. The Fig-2 shows the effect of pulp brightness on OWA consumption for the desired paper brightness.

The above analysis shows that, the response of OWA depends on the basic pulp brightness. One has to optimize the conditions based on cost effectiveness of

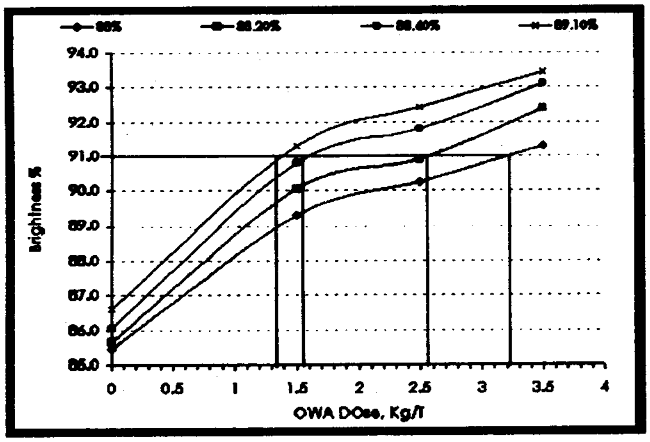

Figure 1: Performance of OWA

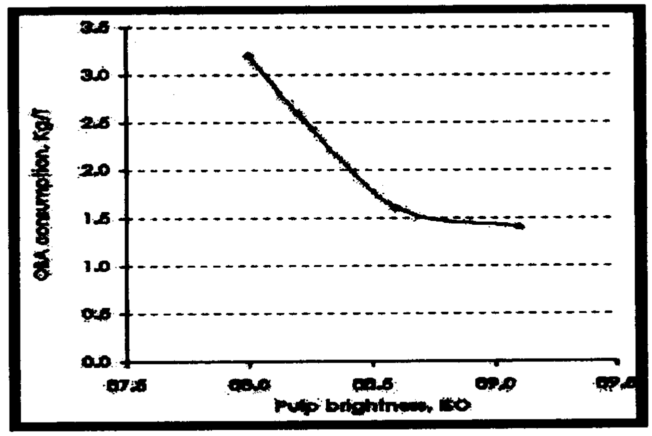

Figure 2: Pulp Brightness & OWA requirement

Pulp Brightness ISO, %	88.0	88.2	88.6	89.1
OWA Consumption, Kg/T	3.2	2.6	1.6	1.4

bleaching process vis a vis OWA consumption which depends on level of paper brightness required and input cost. Papermaker has to balance the bleaching chemicals and optical whitener cost for effective and useful use of the chemicals.

From Fig-2, it may be seen that lower the pulp brightness, higher will be optical whitening agent consumption. Even a small change in pulp brightness has significant influence on OWA consumption. However the use of optical whitening agent has its own limitation as it starts giving graying effect after certain level. So it is not necessary that the use of OWA can develop brightness in paper to the desired level. Effective utilization of OWA is possible with higher initial pulp brightness and every single point initial brightness is important.

Normally, developing paper brightness becomes a problem, particularly when there is a change in raw material furnish. We have carried out bench scale evaluation after analyzing process data to study this behavior. The analysis of process data and following bench scale evaluation describes the details of optimized conditions for individual bleaching stage for developing better final pulp brightness for a given furnish.

Raw material furnish and Final pulp brightness

In view of change in the raw material furnish and constraints in developing final pulp brightness, wood furnish data and final pulp brightness data was analyzed. Fig-3 shows the variations in the final pulp brightness Vs wood furnish during that period.

The mill uses bamboo, Subabul with bark, Eucalyptus and small quantities of mixed hardwoods. Fig-3 shows the followings:

- Increased % of Subabul with bark affects the pulp brightness adversely.
- Whenever there is a trend of increased use of bamboo in the wood furnish, the better brightness development in the final bleached pulp is achieved

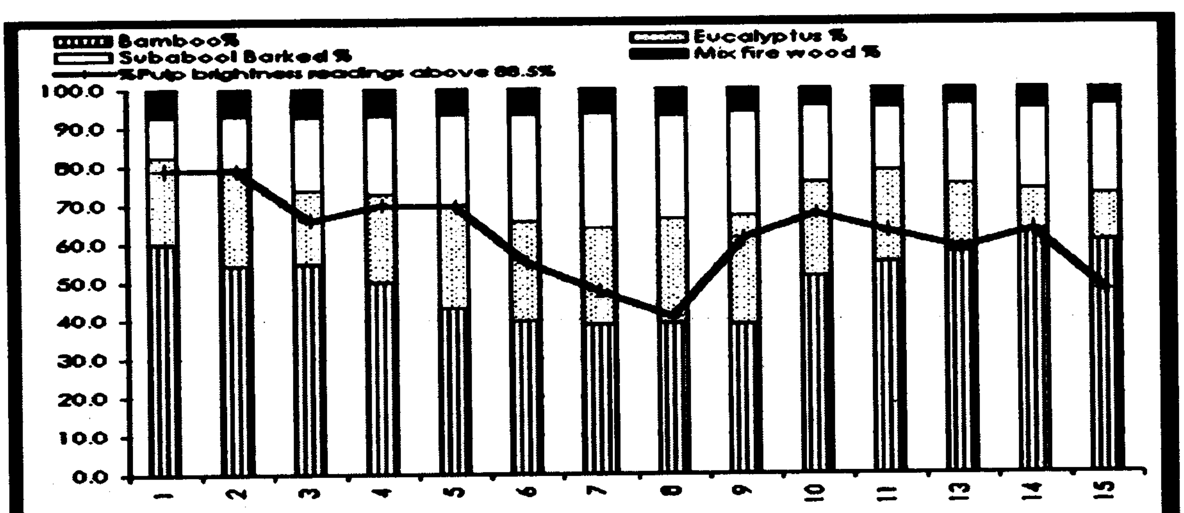

Figure 3 : Raw material Furnish & Pulp brightness

when the proportion of eucalyptus is increased & subabul is reduced in the mix.

Fig- 4 shows correlation between brightness development and proportion of eucalyptus and subabul in the furnish.

In view of the above observations, it was decided to evaluate the performance of individual species for development of final bleached pulp brightness in bench scale study while maintaining all cooking and bleaching conditions similar to plant conditions (Table-1).

Subabul is known for better pulping properties at higher yield, lower cooking chemical consumption and better bleachability of pulp. But the observation in the present study was contrary to the established facts. It might be due to the fact that average size of subabul wood reduced significantly. This might have increased bark content.

It was decided to evaluate the species of different diameter and bark of subabul for the cooking and bleaching properties.

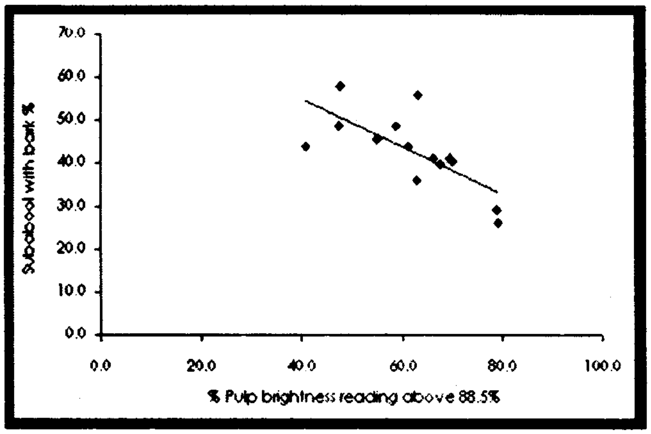

Figure 4 (a) : Proportion of Subabul & Pulp Brightness

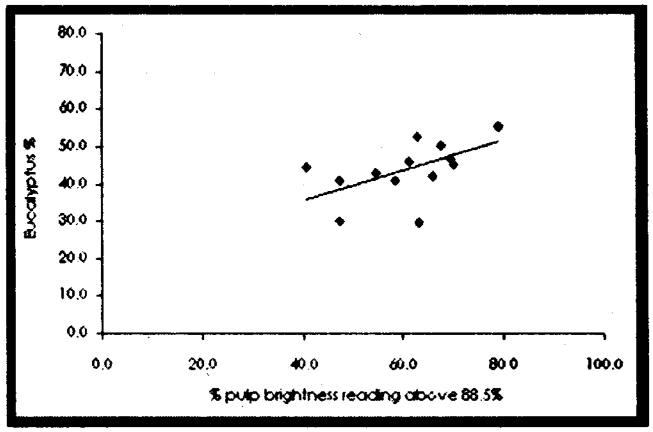

Figure 4 (b) : Proportion of Eucalyptus & Pulp Brightness

Bench scale evaluation of Raw material Species:

Table-1: Bench scale evaluation of Species of Raw Material furnish

Particulars	Normal Bamboo	Debarked Eucalyptus	Subabul with bark	Mixed fire wood
All the species cooked under same condition and AA dose of 22.5% on OD wood				
K. No	15.8	16.7	15	24.6
AA Demand, Kg/T	339	397	336	388
UB pulp Yield, %	47.2	44.5	47.8	44.1
Bleaching with CD Eop HHD under identical conditions				
Total Cl_2 consumed, %	8.31	8.05	7.85	8.15
Final Brightness, %	87.2	89.9	86.4	80.1

Table-1 shows that the brightness development is better at increased % of bamboo only when the brightness drop due to bamboo is getting compensated by the increased portion of the eucalyptus having best bleachability in the furnish at constant mix wood addition in the furnish. The same is proven in the study shown in Table-2.

Table-2 : Bench scale bleaching study with mixed furnish

Particulars	Unit	Set-I	Set-II
Normal Bamboo	%	29.0	28.7
West Chanda Bamboo	%	29.0	28.7
Old Bamboo	%	9.0	9.0
Subabool with bark	%	**8.2**	**20.4**
Eucalyptus (Debark)	%	**19.6**	**7.8**
Mix fire wood	%	5.2	5.2
Bleaching with CD Eop HHD under identical conditions			
Total Chlorine Consumed	%	7.976	7.973
Final Brightness, Elrepho	%	**89.2**	**88.0**

The evaluation of debarked subabul of different sizes (>75mm, 50mm & <50mm diameter) and subabul bark shows that

- Subabul bark gives very low UB pulp yield (25.7%), more Shives (0.6%), poor bleaching response (Final Brightness-66%), and poor cleanliness of bleached pulp.

The details are given in Table-3.

Table 3: Bench scale evaluation of Different size Subabul Wood

Pulping properties:

Particulars	Unit	Subabul debark with a diameter of			100%
		75 mm & more	50mm	Less than 50mm	Subabul bark
Bark % on OD basis	%	4.4%	7.2%	15.7%	
Screened Yield	%	47.8	47.5	46.1	25.1
Permanganate (K) No	No	14.5	14.7	15.5	19.4
Active Alkali Demand	Kg/MT of UB pulp	360	360	355	678

Bleaching Properties

Particulars	Unit	Subabul debark with a diameter of			100%
		75 mm & more	50mm	Less than 50mm	Subabul bark
Bleach Pulp Yield	%	91.3	90.7	88.4	88.3
Total Cl_2 added	%	7.55	7.55	7.55	7.55
Total Cl_2 consumed	%	7.25	7.20	7.17	7.23
Brightness, ISO	%	89.6	89.4	88.2	66.0

- Smaller diameter (20-25mm) subabul wood has more % of bark (15.7%) than the Subabul of diameter more than 50mm (4.4-7.2%).
- Smaller diameter (20-25mm) Subabul pulp has lower brightness development by one point during bleaching under identical conditions.

In view of raw material scenario, it becomes necessary to optimize the bleaching process conditions as per the requirement of available raw material furnish. The bench scale evaluation can give a valuable guideline for process optimization in the plant.

In view of higher proportion of bamboo in the furnish, the mill has faced constraints in developing brightness above 88% ISO in the pulp. To address this problem, bench scale evaluation was carried out to identify the suitable process conditions for full development of brightness at the final stage of bleaching sequence.

Optimization of Chlorine Di- Oxide Bleaching Stage

Mill is using C_DEopHHD bleaching sequence. The final development of brightness of pulp in D- Stage depends on many factors other than process conditions as given below

- Bleaching response of the raw materials species in furnish.
- Ceiling brightness of the individual species.
- Preceding bleaching stage.

Due to less control with the papermaker on these issues, it has been decided to evaluate the effect of following parameters on the development of brightness in the final pulp.

- Effect of brightness of the hypo stage pulp.
- Effect of pH in Chlorine di-oxide performance.

When higher proportion of hardwood was used in furnish, the 82-83% ISO brightness hypo bleached pulp was easily bleached with chlorine di oxide to 88-89%

Table-4 : Effect of Brightness of pulp entering D- Stage on final pulp brightness

Properties of Hypo Stage Pulp:						
pH		7.1	7.1	7.7	7.1	7.0
Residual Cl_2	%	0.028	0.033	0.048	0.029	0.01
Brightness, ISO	%	78.1	81.5	83.0	84.1	85.5
Bleaching with Chlorine Di Oxide						
ClO_2 Dose	kg/T	9.0	9.0	9.0	9.0	9.0
End pH of filtrate		2.4	2.5	2.5	2.3	2.3
Residual Chlorine as ClO_2		0.03	0.0	0.013	0.004	0.086
Brightness, ISO	%	85.9	87.0	88.7	88.7	88.7

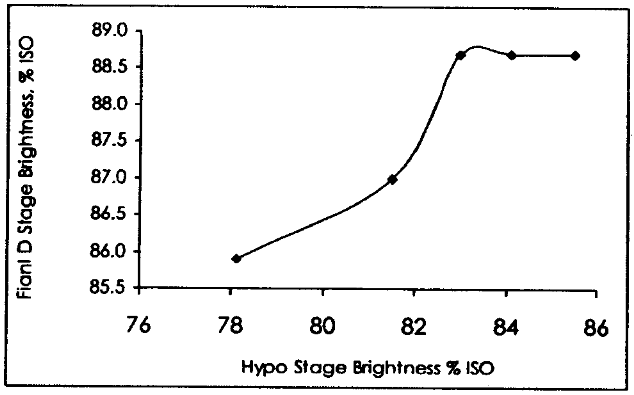

Figure 5 : Effect of Hyo Stage brightness on D-Stage pulp brightness

ISO brightness. But when the bamboo % increased, it was difficult to reach final brightness of 88% ISO. So it was decided to evaluate the performance of hypo bleached pulp of different brightness for chlorine di-Oxide stage. The bench scale evaluation was carried out with plant hypo bleached pulp. The results are tabulated in Table-4.

Normally brightness after hypo stage should be about 81-82% ISO for pulp bleachability and strength point of view. However Fig-5 shows that at higher % of bamboo in the wood furnish, requirement of hypo bleached pulp brightness entering to the ClO2 Stage is more that 83% ISO to develop the brightness of final bleached pulp to 88+% ISO. This is not normally recommended and one should make effort to keep it around 82% & optimize other parameter to achieve the final brightness.

The process scale experience also confirms the above observations and final bleached pulp brightness was increased to 88% ISO on consistent basis.

Effect of pH on ClO_2 bleaching Stage

Simultaneously, bench scale evaluation was carried out to study the effect of pH on ClO2 stage performance. It has been observed that the performance of ClO2 depends on the previous bleaching stage and raw material furnish.

The following evaluation was carried out with plant hypochlorite bleached pulp. The results of the bench scale evaluation are tabulated in Table- 5.

Fig-6 shows that the pulp can be bleached to its maximum limiting value under defined conditions if the end pH of the ClO2 Stage is maintained around 3.0. If the pH rises above 3.0 to 3.5, it does not affect the performance as much as it does falling below 3.0.

Table-5 : Effect of terminal pH on D- Stage Performance

Particulars	Unit		$C_DE_{OP}H_1H_2D$			
ClO_2 as ClO_2	%	0.9	0.9	0.9	0.9	0.9
Res. ClO_2 as ClO_2	%	0.037	0.027	0.022	0.007	0012
End pH in D stage		2.6	2.8	3.1	3.6	4.1
Brightness, ISO	%	89.8	90.1	90.3	90.2	89.9
Reverted Brightness	%	83.0	83.4	83.4	83.1	83.5

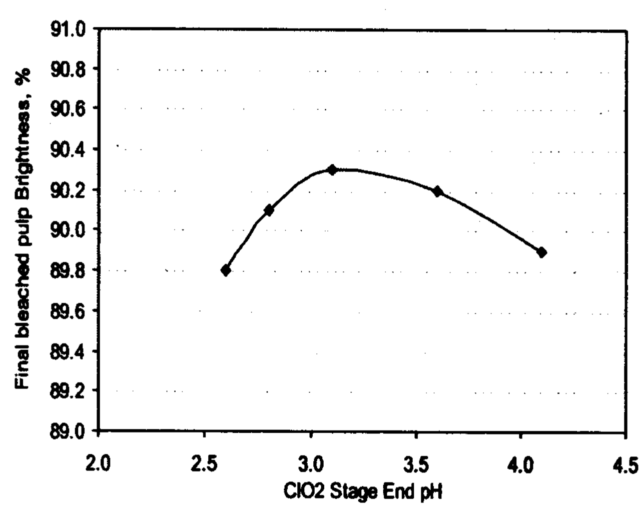

Figure 6 : End pH of D-Stage Vs Pulp Brightness

CONCLUSION

In the higher brightness range, i.e. above 88% ISO, every fraction of pulp brightness is important for high brightness bleached pulp to get the full advantage in terms of quality and profitability. It is of paramount importance that pulp must be bleached to its fullest potential in bleach plant by optimizing the process conditions of individual bleaching stage.

As per the study discussed in the paper for a bleaching sequence of CD EopHHD for bamboo/ hardwood furnish, the brightness at hypo stage preceding D-stage must be optimized to get full development of brightness in the final stage as well as pulp strength by maintaining viscosity at different stages of bleaching sequence. Similarly, end pH of D- Stage tower stock is an important factor. If the end pH at D- Stage is optimized for a given furnish, maximum brightness gain can be achieved in the final D-stage.

For better bleachability of pulp depending on the final product, papermaker has to develop a strategy for the raw material sourcing so that the defined raw material mix will be available for better management of process parameters within a given tolerance.