Utilization Of Tropical Mixed Hard Wood Pin Chips For Kraft Pulping

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ABSTRACT

In the present investigation, a judicious effort is done to explore the possibility to re-use pin chips for making bleach grade pulp. The most commonly used hard woods are Eucalyptus, Acacia, Casuarina and Subabul etc. In the background of this, the present work on hard wood pin chips pulping was taken to augment the present and projected raw material shortages. Pin chips are separated from chipper dust and cooked with varying dose of active alkali, followed by ECF bleaching sequence. In pulping, variation of active alkali (as Na_2O), bath ratio, cooking temperature and cooking time was closely monitored. Bleaching was done with different doses of ClO_2 in D_{HT} and D_1 stage and H_2O_2 in E_P stage. In pulping experiment, kappa number target of 18 to 20 was fixed and same pulp after initial optimization in pulping was considered for bleaching. In bleaching, the target brightness of the pulp was fixed at around 89 to 90% and same could be achieved.

***Keywords*:**Pin chips, Kappa No, Viscosity, Active Alkali, Bath Ratio, Mixed Hard Wood kraft pulp, Brightness,ECFbleaching

Introduction

An ever increasing demand for paper has kept the Indian paper industry rolling. The foremost thing which must be kept in mind is the availability of fibrous raw material which of late has become scarce. The wood based raw material comprises of about 40% of the total raw material demand. Indian wood based pulp mills are using mixed hard woods. The most commonly used hard woods are Eucalyptus, Acacia, Casuarina and Subabul etc. The regularly used raw materials are subjected to chipping before pulping. In the chipping process, dust fraction is generated which also consists of useful pulpable pin chips, which are very valuable and precious from the point of view of raw material conservation and must be separated from fine dust. On an average about 2.0 to 2.5 percent of mixed hard wood pin chips is lost. If not judiciously separated may lead to National waste. If for example the chipping rate is 3000 tonnes per day, then the lost mixed hard wood pin chips or pulpable useful material is about 60 to 75 tonnes per day. Naturally the raw material output in terms of yield etc. is lost if not re-used. Due to present and projected raw material shortage, it has become imperative to go for alternative materials. If such is the scenario, it's a very good and novel idea to separate mixed hard wood pin chips from dust and re-use the same for kraft pulping.

The main objective of the present study is to have an insight into the dust fraction, which is the left over material after mixed Hard Wood chips screening. To use pin chips into pulpable raw material and to establish the same, influence of the basic cooking parameters (Active Alkali as Na_2O, Bath Ratio, Cooking Temperature and Cooking Time) and the pulp properties (Screened Yield, Screened Reject, Kappa No and viscosity) in kraft pulping were studied. In the present study, the optimised cooking conditions with the target kappa number of about 18 to 20 was selected for ECF bleaching. In bleaching studies, variation in chlorine dioxide (ClO_2), dosing in $D_{HT,}D_{1,}$ and hydrogen peroxide (H_2O_2) variation in E_P stage was studied with the target brightness of about 89 to 90%. The results are shown in the tabular form and depicted in the graph.

ROTARY DIGESTER

AUTOCLAVE DIGESTER

MIXED HARD WOOD PIN CHIPS

MIXED HARD WOOD FINE DUST

Experimental

Kraft Pulping

Tropical mixed hard wood pin chips pulp was prepared in laboratory by kraft process. Pulping was done in an Autoclave digester of capacity of around 5L, under various cooking conditions by taking 200 grams of oven dried (o.d.) mixed hard wood pin chips in order to get the target kappa number of 18 to 20 by variations in cooking parameters viz. Active Alkali as Na_2O, Bath Ratio, Cooking Temperature and Cooking Time. The results are given in Table 1.

From the Table 1. It is obvious that 19.5% active alkali with 1:3 Bath Ratio at 160 °C for 3½hr. has been found to be optimum in getting the target kappa number of range 18 to 20. The conventional large scale cooking was carried out in 15L capacity thermostatically controlled electrically heated Rotary Digester

Table 1
Cooking data on mixed hard wood kraft pulping by variations in cooking parameter

Parameters	**White Liquor Charge**				**Bath Ratio**			**Cooking Temperature**			**Cooking Time**		
	16.5 %	18%	**19.5%**	21%	1:2.5	**1:3**	1:3.5	155^0C	**160^0C**	165^0C	3 hr	**3 ½ hr**	4 hr
Screened Yield (%)	41.00	40.00	**39.50**	39.10	40.80	**40.20**	38.90	40.70	**40.10**	39.80	40.50	**40.30**	39.19
Screened Reject (%)	3.00	2.82	**2.40**	1.99	2.00	**2.30**	3.40	3.40	**2.40**	2.00	5.30	**2.70**	1.70
Kappa Number	24.3	23.1	**19.5**	18.5	21.0	**19.8**	19.1	22.8	**19.3**	18.9	23.0	**19.0**	17.8
Viscosity (centi poise)	20.2	19.64	**16.6**	15.91	16.5	**15.9**	15.5	19.0	**16.9**	16.0	19.0	**16.0**	15.2
Residual Active Alkali(gpl)	6.9	8.8	**10.0**	12.4	13.6	**11.0**	10.3	12.1	**10.80**	9.9	11.8	**9.4**	7.6

Table 2 : Cooking data on mixed hard wood kraft pulping by optimized cooking parameters

SL.No.	Particulars	Units	Mix HW pin chips
1	Active Alkali Added on HW Pin Chips	%	19.5
2	Wood to Liquor Ratio (Bath Ratio)	-	1:3
3	Un Bleached Pulp Screened Yield	%	40.94
4	Un Bleached Pulp Screened Reject	%	2.82
5	Kappa No	-	19.00
6	Un Bleached Pulp Brightness	%	31.32
7	Un Bleached Pulp Viscosity	cps	15.15
8	R.A.A as Na_2O	gpl	10.5
Cooking Schedule		**70 – 120 °C --------45 mins. At 120 °C --------45 mins. 120 – 160 °C -------60 mins. At 160 °C -------60 mins.**	

Table 3: ECF bleaching by variation of ClO_2 dose in D_{HT} stage

Particulars	Units	I	II	III	I	II	III	I	II	III
		D_{HT} Stage			E_P Stage			D_1 Stage		
								D_2 Stage		
ClO_2 Charge	%	**2.3**	**2.8**	**3.2**	-	-	-	1.0	1.0	1.0
								0.3	0.3	0.3
Alkali Charge	%	-	-	-	2	2	2	-	-	-
Peroxide Charge	%	-	-	-	1	1	1	-	-	-
Temperature	°C	80	80	80	75	75	75	80	80	80
Consistency	%	10	10	10	10	10	10	10	10	10
Retention Time	min	90	90	90	75	75	75	90	90	90
								60	60	60
Result										
Brightness	%	52.10	55.60	56.00	80.20	81.70	82.30	86.40	88.80	89.60
Viscosity	cps	-	-	-	-	-	-	9.80	9.50	9.00
Chemical Consumption	%	99.70	99.80	99.50	97.90	98.00	98.20	98.20	98.50	98.40

Table 4: ECF bleaching by variation of H_2O_2 dose in E_P stage

Particulars	Units	I	II	III	I	II	III	I	II	III
		D_{HT} Stage			E_P Stage			D_1 Stage		
								D_2 Stage		
ClO_2 Charge	%	**2.8**	**2.8**	**2.8**	-	-	-	1.0	1.0	1.0
								0.3	0.3	0.3
Alkali Charge	%	-	-	-	2	2	2	-	-	-
Peroxide Charge	%	-	-	-	**0.8**	**1.0**	**1.2**	-	-	-
Temperature	°C	80	80	80	75	75	75	80	80	80
Consistency	%	10	10	10	10	10	10	10	10	10
Retention Time	min	90	90	90	75	75	75	90	90	90
								60	60	60
Result										
Brightness	%	56.16	56.06	56.26	81.60	82.30	82.90	87.10	89.00	89.30
Viscosity	cps	-	-	-	-	-	-	10.00	9.80	8.90
Chemical Consumption	%	99.80	99.80	99.70	98.87	98.30	98.58	98.50	98.70	98.60

Table 5 : ECF bleaching by variation of ClO_2 dose in D_1 stage

Particulars	Units	I	II	III	I	II	III	I	II	III
		D_{HT} Stage			E_P Stage			D_1 Stage		
								D_2 Stage		
ClO_2 Charge	%	**2.8**	**2.8**	**2.8**	-	-	-	**0.5**	**1**	**1.5**
								0.3	0.3	0.3
Alkali Charge	%	-	-	-	2	2	2	-	-	-
Peroxide Charge	%	-	-	-	1	1	1	-	-	-
Temperature	°C	80	80	80	75	75	75	80	80	80
Consistency	%	10	10	10	10	10	10	10	10	10
Retention Time	min	90	90	90	75	75	75	90	90	90
								60	60	60
Result										
Brightness	%	56.10	56.30	56.20	81.40	82.10	82.50	87.90	89.20	90.30
Viscosity	cps	-	-	-	-	-	-	10.1	9.70	9.10
Chemical Consumption	%	99.70	99.80	99.60	98.00	98.30	98.20	98.65	98.50	98.40

dosing 1000grams of oven dried (o.d.) mixed hard wood pin chips taking the cue from the initial optimisation experiments. At the end of pulping, pressure was released to atmospheric pressure; pulp was taken out from the digester, disintegrated and washed under continuous flow of water, till the pulp is fully free from alkali. Pulp was screened in a valley laboratory flat screen with 0.15mm slots, centrifuged and homogenised. Screened yield and Screened rejects were determined. Pulp yield was determined as dry matter obtained on the basis of oven dried (o.d.) raw material. Kappa number and viscosity was determined in accordance with TAPPI standard method (T-236 cm-85 and T-230 om-99 respectively). Kappa number, viscosity and brightness of the unbleached pulp were found to be 19.0, 15.2 cps and 31.3% respectively. The Residual Active Alkali was determined and is found to be 10.5 gpl. The results are given in Table 2.

ECF Bleaching

Pulp was bleached by $D_{HT}(E_P)D1\&D2$ bleaching sequence (where D represents Chlorine Dioxide and E_P represent Peroxide reinforced alkaline extraction). Keeping in view, final brightness of bleach pulp at 89 to 90%, various doses of ClO_2 and H_2O_2 were carried out in D and E_P stages of bleaching sequence respectively. The results are shown in Table 3, 4 and 5.

From Table 3, 4 and 5. It is clear that 2.8% ClO_2 in D_{HT} with 0.8% H_2O_2 in E_P, 1% ClO_2 in D_1 and 0.3% ClO_2 in D_2 was found to be optimum to achieve target brightness ofabout 89 to 90%. In D_{HT} (E_P) D_1D_2 bleaching sequence, the D_{HT} stage was carried out for 90 min. at 80 °C with an exit pH in the range of 2.0 to 2.5 and consistency 10%. The E_P stage with 0.8% H_2O_2 was conducted at 75 °C and 10% consistency with the retention time of 75 minutes. To maintain pH around 10 to 11, 2% NaOH

was added. D_1 stage was carried out at 1% ClO_2 and D_1 pulp was then extracted with caustic and pH was reduced to about 2.5 to 3, before adding ClO_2 at the dose of 0.3%. The total time for D_1 and D_2 was 150 minutes (D_1: 90min, D_2:60min) at 80°C and 10% consistency.Under optimized conditions, Brightness, Viscosity and Yield of bleached pulp was found to be 89.40%, 9.83 cps and 39.2% respectively. The results are given in Table 6.

Table 6
ECF bleaching data on mixed hard wood pin chips kraft pulp by optimized bleaching parameters

SL.No	Particulars	Units	Mixed HW pin chips kraft pulp
1	**D_{HT} Stage**		
	ClO_2 charge	%	2.8
	Temperature	°C	80
	Consistency	%	10
	Retention Time	min	90
2	**E_P Stage**		
	Alkali charge	%	2.0
	H_2O_2 charge	%	1.0
	Temperature	°C	75
	Consistency	%	10
	Retention Time	min	75
3	**D_1 Stage**		
	ClO_2 charge	%	1.0
	Temperature	°C	80
	Consistency	%	10
	Retention Time	min	90
4	**D_2 Stage**		
	ClO_2 charge	%	0.3
	Temperature	°C	80
	Consistency	%	10
	Retention Time	min	60
	Results		
	Brightness	%	89.40
	Viscosity	cps	9.83
	Shrinkage	%	4.2
	Bleached Pulp Yield	%	39.2

Result and Discussion

Table 1.Shows pulping conditions and results of the tested parameters viz. Screened yield, Rejects, Kappa number, Viscosity and Residual Active Alkali. The unbleached pulp kappa number at the active alkali of 16.5% to 21% is 18.5 to 24.3. With the change in bath ratio from 1:2.5 to 1:3.5 the kappa number range is 19.1 to 21.0. In the temperature variation from 155 to 165 °C, the kappa number range is 18.9 to 22.8 and lastly with variation in cooking time from 3 to 4 hr. the kappa numberrange is 17.8 to 23.

In the above different parameters, the overall screened yield is from 38.9% Min to 41.0% Max. Screened reject is from 1.7% to 5.3%. Kappa number is from 17.8 to 24.3. Viscosity is from 15.2 to 20.2 cps. And finally the Residual Active Alkali is from 6.9 to 13.6 gpl.

Table 2. From the initial findings of optimization, the large scale screened pulp yield was 40.9% at the kappa number level of 19.0 and the corresponding unbleached pulp viscosity was 15.2 cps.

Table 3. It is clear from the findings that 2.8% $ClO_2$is needed to get about 55.6% of Brightness, and with 3.2% ClO_2, the brightness is 56.0%.

Table 4. With different dose of H_2O_2 in E_P[0.8 to 1.2%] stage at the constant alkali charge of 2.0%, the Brightness is 81.6, 82.3 and 82.9% respectively. Thus an optimum of 1.0% $H_2O_2$is enough to get 82.3% of Brightness pulp in E_P stage.

Table 5. With varying dose of ClO_2 in D_1 from 0.5 to 1.5%, the Brightness of 89.2% was achieved at 1.0% ClO_2 in D_1 and 0.3% in D_2stage.

Table 6. From the initial findings of optimization, the large scale ECF bleached pulp yield was 39.2% at the brightness level of 89.40% and the corresponding bleached pulp viscosity was 9.83 cps.

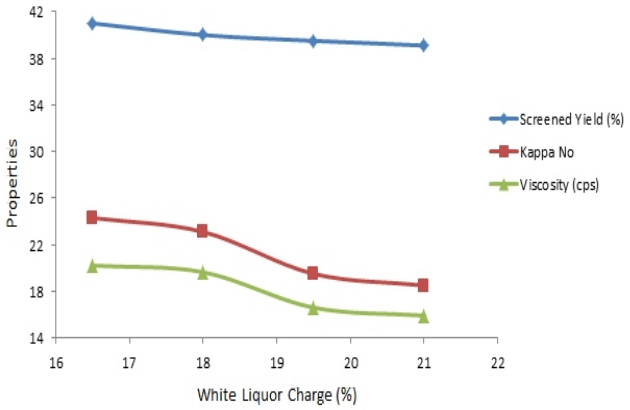

Figure 1. Effect of White Liquor Charge on Screened Yield, Kappa No. and Viscosity

From the Figure 1.It is clear that at increasing dosage of active alkali from 16.5 to 21%, there is a proportional reduction in Kappa number, Yield and Viscosity.

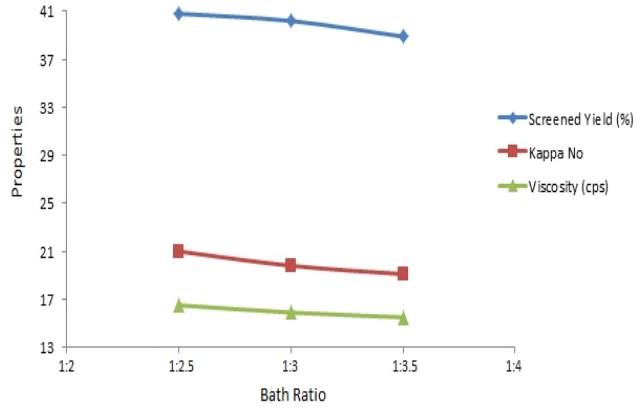

Figure 2. Effect of Bath Ratio on Screened Yield, Kappa No. and Viscosity

As shown in Figure 2. With increase in the bath ratio i.e. wood: liquor, from 1:2.5 to 1:3.5, there is a gradual drop in Screened

Yield, Kappa No. and Viscosity. However due to lower concentration of alkali at higher bath ratio, rejects are on higher side.

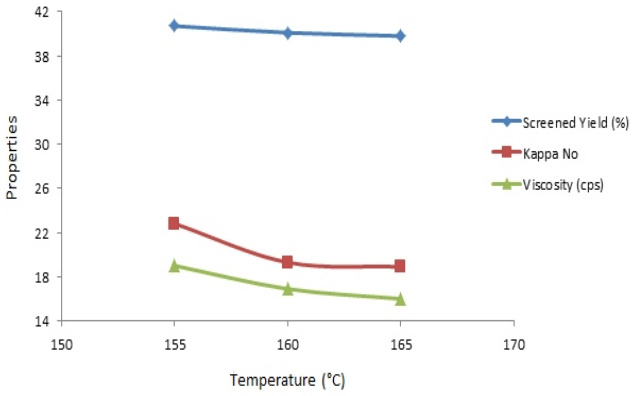

Figure3. Effect of Temperature on Screened Yield, Kappa No. and Viscosity

As shown in Figure 3.Increase in cooking temperature, from 155 to 165 °C, screened yield, kappa number and viscosity are on the lower side. This is again due to the higher rate of delignification as the temperature increases.

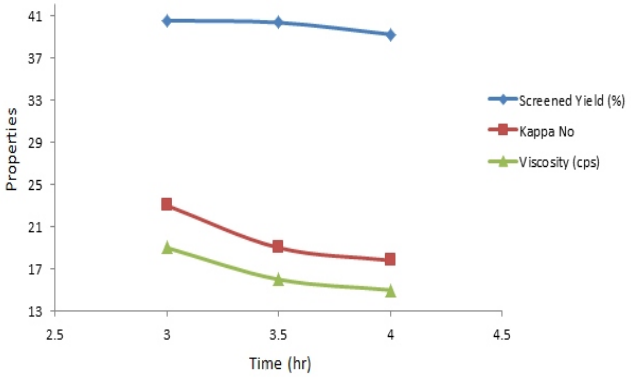

Figure4. Effect of CookingTime on Screened Yield, Kappa No. and Viscosity

As shown in Figure 4.Higher retention time at the final cooking temperature, there is a gradual but definite decrease in the final screened yield, kappa number and viscosity. This is due to acceleration in the delignification because of higher retention time.

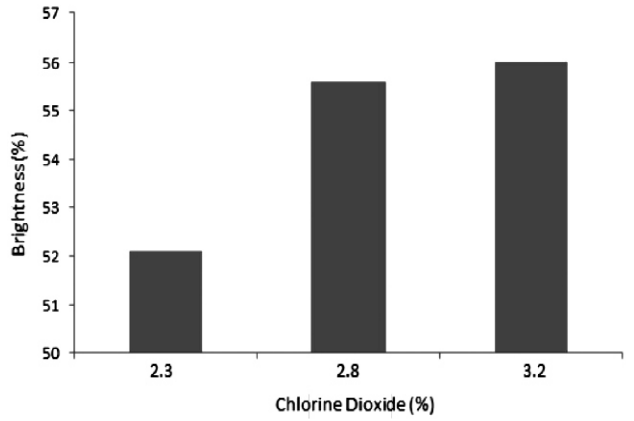

Figure 5. Effect of Chlorine Dioxide on D_{HT} Brightness

As ClO_2 dose is increased from 2.3 to 3.2%, the brightness of D_{HT} pulp is on the upswing from 52.1% at 2.3% to 56.0% at 3.2% ClO_2as depicted in Figure 5. However from the graph it is clear that 2.8% ClO_2 dose seems to be optimum.

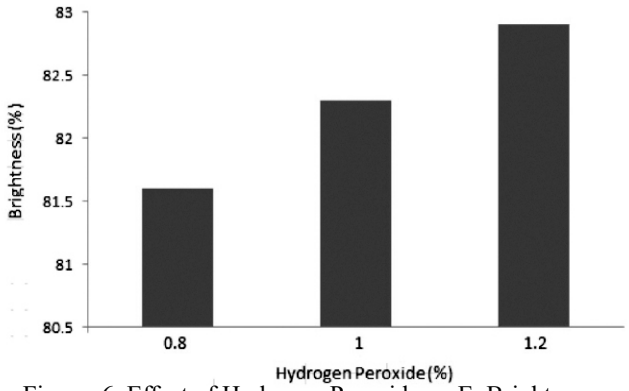

Figure 6. Effect of Hydrogen Peroxide on E_P Brightness

As shown in Figure 6. H_2O_2 in E_P stage is varied from 0.8 to 1.2%. The up shoot in E_P stage brightness is 81.6% minimum and 82.9% maximum. Here again it's clear that, 1.0% H_2O_2 seems to be congenial.

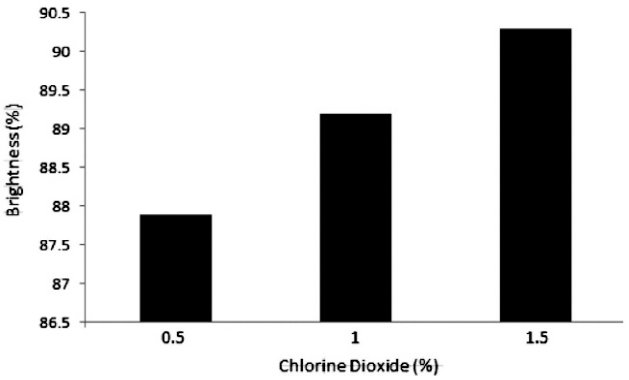

Figure 7. Effect of Chlorine Dioxide on D_2 Brightness

As shown in Figure 7. With increase in ClO_2 dose in D_1 stage from 0.5 to 1.5%, and keeping 0.3% same in D_2 stage, the brightness of the total pulp has gone up from 87.9 at 0.5% to 90.3% of 1.5% ClO_2 dose. However, the optimum dose of ClO_2 in D_1 stage seems to be 1%

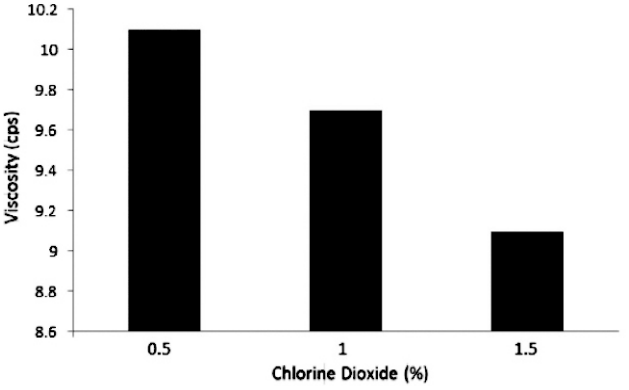

Figure8. Effect of Chlorine Dioxide on D_2 Viscosity

From Figure 8.As inferred in the earlier findings 1.0% ClO_2

seems to be optimum both from the point of view of viscosity and final brightness..The drop in viscosity of the final pulp is from 10.1 cps at 0.5% ClO_2 in D_1 to 9.1 cps at 1.5% ClO_2, keeping constant 0.3% ClO_2 charge in D_2 stage.

Conclusion

The present study on judicious utilization of mixed hard wood pin chips from the dust is quite exhaustive and has covered all the variations in the basic parameters from pulping to bleaching. A concerted and sincere effort has been made in arriving at the vital but definite conclusions which is made possible by jumbling all permutations and combinations.

- Brightness of bleached pulp is achieved 89.4%.
- Shrinkage recorded 4.2%.
- Viscosity of bleached pulp is 9.83 cps.
- Final bleached pulp yield is 39.2%, slightly lower than whole chip yield.

In nut shell, Hard Wood pin chips can be a very useful source of raw materials as it nearly accounts for 2.0 to 2.5% of the total raw material. This study concludes clearly that, pin chips can be used for production of ECF bleached grade pulp.

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