Impact Of Bark On Fiber Line And Recovery Operations

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ABSTRACT

With dwindling availability of wood, variety of species are being used for pulp production ranging from Eucalyptus hybrid, Casuarina, Subabul, Wattle, Blue gum, Acacia etc. Some varieties are used as such with bark, due to their thin structure and difficulty in removing. The bark portion of the wood is not desirable for pulping, due to its low fiber value and accumulated non process elements (NPE) such as Ca, Mg, Si, Cl, etc. which find their way into the process and also affect pulp processing and quality. The NPE's create problems in the process such as scaling, corrosion decreasing process efficiency. The present study discusses the advantages of bark removal from different species, on pulping and chemical recovery process. In spite of higher cost for debarking, bark removal does have economical advantage in terms of pulp throughput and decreased NPE accumulation in the system.

INTRODUCTION:

Cost competitiveness comes from good manufacturing practices and technology updation. With increased competition, the control of cost of production takes a primary role in improving cost competitiveness. Updating and implementing latest technologies which are energy efficient and less water intensive have been followed in many of the mills and they have paid back accordingly. As a step further in cutting down the cost, systems such as Quality Management systems and Environment management systems have paved way for systematic control of the process, controlling wastages and thereby the cost.

The adaptation of latest technology in every operation of the paper industry has lot of potential in terms of cost reduction as well as becoming environment friendly. There has been a serious focus on pulpmill operations both from quality and environmental view point. It is the need of the hour to maximize operational efficiencies and productivity of whatever systems we operate today.

The modern concept of manufacturing stresses on the control of the inputs into the process, rather than controlling the process according to the changes in inputs. Input raw materials into the process, when controlled, results in constant output, under given set of process conditions. Applying this to the pulp and paper industry, control of the variations in incoming raw materials will result in a more uniform output pulp. But under the present scenario of dwindling availability of wood, mills are forced to use varied raw materials such as Eucalyptus, Casuarina, Subabul, Wattle wood, Blue gum and whatever locally available woods for pulp manufacture. This being one of the criteria, pulping of wood without mixing the varieties is suggested for better control. As a further step in improving quality, productivity and uniformity of output, removal of bark from the wood is the necessary step, which in addition to the benefits also results in reduced entry of the Non Process Elements (NPE) into the paper making cycle, particularly the recovery cycle. Control of NPE is the need of the day to improve the process efficiency and improved productivity. The paper discusses the role of bark removal on the performance of fiber line and the recovery operations.

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The wood costs constitutes 50-75% of the manufacturing cost of pulp. Wood procurement operations will have an immediate effect on the overall economy which is greater than that of most improvements in the pulping processes.

The presence of bark on the pulpwood is not as detrimental to pulp cleanliness in the Kraft as in the sulfite process, since a large part of the bark impurities are dissolved in the cook. However since the bark yields only little fiber, but consumes much alkali, the market value of the pulpwood with 10% bark is only about 80% of that bark-free wood (1)

BARK IN WOOD

Log debarking is necessary to ensure that the wood chips are free of bark and dirt. However in almost all of Indian mills, the debarking is carried out manually at the felling site. Since this is a highly labour intensive operation, in foreign countries, several types of mechanical debarkers are used. Removal of bark is necessary as it has negligible useful fiber, darkens the pulp, requires extra chemical usage, leads to process problems such as excessive foam generation, and introduces contaminants such as Calcium, Silica, Aluminium into chemical recovery system(2).

Amounting to about 10-15% of the total weight of the tree, debarked wood is normally used for pulping and even traces of bark residues detrimentally affect the pulp quality (3).

The inner bark is meant for transportation of liquids and nutrients, while the outer bark protects the wood tissues against mechanical damage and preserve it from temperature and humidity variations.

Chemistry of bark

Bark is composed of high content of certain soluble constituents (extractives) such as pectin and phenolic compounds as well as suberins. Mineral content of bark is also much higher than that of wood.

The soluble constituents comprise of extractives that are lipophilic and hydrophilic. The insoluble constituents comprise of polysaccharides, lignin and suberins. The inorganic constituents are Non process elements (NPEs) such as Silica, Potassium, Calcium, Magnesium, Mixed oxides etc.(3)

Studies with Casuarina and Subabul with bark

Eucalyptus is received in debarked form. Other wood varieties such as Casuarina, Subabul are received with bark. With increased pulp wood demand, wood of different size and different age is received for pulping. They range from lops and tops of 1-2 inches dia to as high as 6-8 inches dia wood, which are comparatively matured. The bark content of the wood varies with the age of wood.The following tables give the bark content of Casuarina and Subabul

Table 4: Non process elements in Casuarina and Subabul wood and bark

	Casuarina		Subabul	
	Wood	Bark	Wood	Bark
Silica %	0.005	0.207	0.011	0.29
Mixed oxides %	0.03	0.16	0.04	0.51
Calcium as Cao %	0.26	1.32	0.40	3.09
Magnesium as MgO %	0.03	0.14	0.09	0.21
Potassium as K %	0.055	0.19	0.09	1.51

Table 1 : Ratio of Bark and wood in Casuarina

Sl no	Wood dia	Moisture %		Proportion % as received		Proportion % on OD basis	
		Wood	Bark	Wood	Bark	Wood	Bark
1	1” – 2”	41.8	44.8	90.2	9.8	90.7	9.3
2	2” – 4”	44.4	56.1	91.4	8.6	93.0	7.0
3	4” – 6”	40.0	50.2	89.2	10.8	90.9	9.1

Table 2 : Ratio of Bark and wood in Subabul

Sl no	Wood dia	Moisture %		Proportion % as received		Proportion % on OD basis	
		Wood	Bark	Wood	Bark	Wood	Bark
1	1” – 2”	33.65	82.20	84.6	15.4	95.3	4.7
2	2” – 4”	36.64	83.10	89.0	11.0	96.8	3.2
3	4” – 6”	35.50	77.20	92.7	7.3	97.3	2.7
4	6” – 8”	38.10	76.10	93.7	6.3	97.5	2.5

Table 3: Ash content in Casuarina wood and bark

Wood dia	1”	2”	3”	4”
Proportion on OD basis				
Wood+Bark	100	100	100	100
Wood	88.3	90.3	92.6	91.0
Bark	11.7	9.7	7.4	9.0
Moisture %				
Wood+Bark	46.9	46.6	45.2	35.6
Wood	46.0	45.6	44.2	35.7
Bark	52.6	54.3	54.7	34.5
Ash %				
Wood+Bark	0.59	0.55	0.63	0.74
Wood	0.45	0.41	0.50	0.50
Bark	1.67	1.91	2.31	3.29
Ash contribution by bark %	33.0	33.6	27.1	39.0

As seen from the table, with increasing size of wood with age, the bark proportion decreases. That is to say that immature wood has comparatively higher proportion of bark. Also the moisture content of bark is significantly higher than the woody portion. The bark proportion is higher in case of Casuarina compared to Subabul.

The Non process elements contribution by the bark was studied. First the ash content of different size Casuarina wood and bark was determined. The results are presented below. Samples of billets of different size Casuarina wood were collected and totally ashed. The bark portion was ashed separately and the combined ash content was determined by ratio of wood to bark.

As seen from the table, as the size of the wood increases, though the bark content decreases, the ash content and the ash contribution increases. This shows that the Non process elements accumulation is more in the bark with increased age of wood.
The table - 4 gives the Non process elements such as Calcium, magnesium, Silica, Mixed oxides, and Potassium.

As clearly evident the non process elements concentration is several times higher in bark compared to the woody portion.

To have a better picture of the NPE concentration, let us consider the wood consumption per day, of different species and their NPE contribution per day. The table - 5 presents a typical data.

Total NPEs entering the pulping per day 6784 kg/day out of which 4373 kg/day is contributed by Calcium.

To study the effect of bark on pulping and on black liquor characteristics laboratory pulping studies were carried out with Casuarina and Subabul with and without bark under specified conditions. Before going into the pulping results, the effect of bark content on the bulk density and thus the digester packing needs consideration. The following table gives the effect of bark on bulk density of the wood.

Table 5 : Non process elements contribution by wood per day

Sl.No	Parameter		EH	Subabul	Casurina	Blue Gum	Total
			Debarked	with bark	with bark	Debarked	
1	Wood	%	35.9	30.2	30.8	2.2	100
2	Wood	TPD	423	355	363	26	1176
3	Silica	kg/Day	152.2	81.8	65.3	3.7	305
4	Mixed Oxide(Al +Fe)	kg/Day	329.7	192.0	195.9	9.7	733
5	CaO	kg/Day	967.9	1965.8	1371.3	33.4	4373
6	MgO	kg/Day	63.4	220.4	188.6	11.5	488
7	K	kg/Day	198.7	465.7	199.5	13.0	884

Table 6: Bulk density of wood with and without bark

Sl no	Wood variety	Bulk density kg/m3 (OD)	
		Without bark	With bark
1	Euca hybrid	225	-----
2	Casuarina	233	216
3	Subabul	215	202

Table 7 : Pulping of Casuarina with and without bark

	With Bark	Without Bark
Total Yield %	48.5	50.1
Screen rejects %	0.05	0.05
Screened yield %	**48.5**	**50.1**
Kappa Number	20.0	19.5
Brightness% (ISO)	24.5	30.6
Viscosity cPs	24.0	25.4
Black Liquor		
pH	12.9	13.0
TS	235	230
TTA@200gpl	28.4	31.2
RAA@200gpl	4.4	6.5
Constant pulping conditions		
TAA as Na2O	%	15
H-factor		900
Time	min	70
Temp	°C	165
Sulphidity	%	21

Table 8: Pulping of Subabul with and without bark

	With Bark	Without Bark
Active alkali charged %	**18**	**17**
Total Yield %	45.9	47.8
Screen rejects %	0.07	0.03
Screened yield %	**45.81**	**47.8**
Kappa Number	21.1	22.7
Brightness% (ISO)	29.6	31.0
Black Liquor		
pH	12.8	12.7
TS	259	252
TTA@200gpl	32.2	30.9
RAA@200gpl	11.7	10.8
Constant pulping conditions		
H-factor		900
Time	min	70
Temp	°C	165
Sulphidity	%	21

Table 9: Impact of Bark on NPE in black liquor

Parameter	Casuarina		Subabul	
	With Bark	Without Bark	With Bark	Without Bark
Acid insoluble Silica%	0.15	0.12	0.22	0.10
Inorg as NaOH %	34.23	33.53	---	---
Calcium as CaO %	0.15	0.10	0.036	ND
Magnesium as MgO %	0.06	0.03	0.084	0.058
Chlorides as NaCl %	2.89	2.52	2.61	2.46
Potassium as K %	0.78	1.05	2.50	1.86
R2O3 %	0.13	0.1	---	---
Sulphate as S %	1.37	1.24	---	---
Calorific value kcal/kg	3255	3300	---	---

Table 10: Productivity improvement with Casuarina without bark

	With Bark	Without Bark
Bleached pulp T	1	1
Bleaching loss %	5.58	4.55
Unbleached pulp T	1.059	1.048
Yield %	48.5	50.1
Wood OD/T of pulp	2.056	2.099
Moisture %	45.00	40.00
Wood/T of pulp T	**3.74**	**3.50**
Cost/T of wood Rs	2550	3075
Wood cost/T of bld pulp Rs	9531	10757
Bulk density kg/m3	216	233
Wood/charge T	43.2	46.6
Pulp/discharge T	20.94	23.34
Pulp (13 blow/day) T	272.26	303.41
Addl pulp/day T		31.15
Addl bld pulp/d T		29.7

The bulk density of wood with bark is comparatively lower, which means lower loading in digester per charge, and lower pulp throughput per batch.The pulping results of Casuarina with and without bark are presented in Table - 7

The debarked wood gives 1.6% more pulp yield than the wood with bark. The Unbleached pulp brightness and RAA are also higher. Likewise the pulping of subabul with and without bark also shows similar results

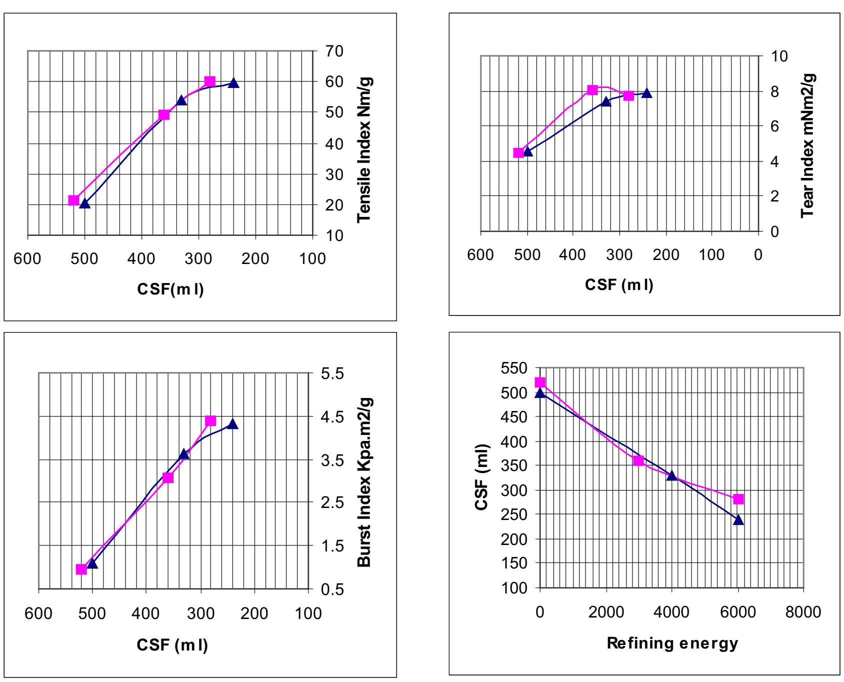
Thus debarking of wood results in higher pulp yield and higher pulp throughput and thus productivity is increased, which is the need of the day. The impact of bark on the NPEs in black liquor was studied. The NPE

Table 11: Productivity improvement with Subabul without bark

	With Bark	Without Bark
Bleached pulp T	1	1
Bleaching loss %	5.58	4.55
Unbleached pulp T	1.059	1.048
Yield %	45.8	47.8
Wood OD/T of pulp	2.312	2.193
Moisture %	42.6	36.0
Wood/T of pulp T	**4.03**	**3.43**
Cost/T of wood Rs	2800	3650
Wood cost/T of bld pulp Rs	11284	12519
Bulk density kg/m3	202	215
Wood/charge T	40.4	43.0
Pulp/discharge T	18.50	20.55
Pulp (13 blow/day) T	240.5	267.2
Addl pulp/day T		26.7
Addl bld pulp/d T		25.5

	▲ With bark	■ Without bark
	@ 300 ml CSF	
Tensile Index N.m/g	58.0	60.0
Tear Index mN.m2/g	7.6	7.9
Burst Index Kpa.m2/g	4.0	4.3
Refining energy PFI rev	4600	5000

Fig 1 : Strength properties of bleached Casuarina pulp with and without bark



concentration in black liquor is presented in Table - 9 for Casuarina and Subabul.
As evident from the table, in spite of higher cost of debarked wood, the cost of bleached pulp will be lower, due to improved productivity.

In addition, the bark poses problems during screening operations, increasing the downtime due to jamming, which has been our practical experience.

The impact of bark removal on strength properties of bleached pulp is presented below. Bark removal results in improved strength properties in terms of tensile, tear and burst. The properties computed at 300ml CSF for Casuarina pulp with and without bark presented bear testimony.

The Casuarina pulp with and without bark was bleached using OO-DHT-EOP-D bleaching sequence to assess the impact of bark on TDS increase in effluent.The impact of bark on COD, TDS in bleach effluent and Post color number of bleached pulp is presented in fig 1,2 and 3.

Conclusion:

From the foregoing data, it is evident that by removing the bark,

- Pulp productivity is improved
- Non process elements entry into black liquor is reduced
- Non process elements mainly Calcium that induces scaling is reduced
- Cost of production of bleached pulp will be lower in spite of higher cost for debarking of wood
- Strength properties are improved
- COD, TDS entry into effluent is reduced
- Post color number of pulp is improved

Acknowledgements:

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References:

1. Pulping process by Rhydolm.
2. Raw material preparation Course notes of Dr G Venkoba Rao Btech Pulp&Paper
3. Wood chemistry, Fundamentals and Applications Eero Sjoestrom (Second edition)

Fig 2 Effect of Bark on COD generation

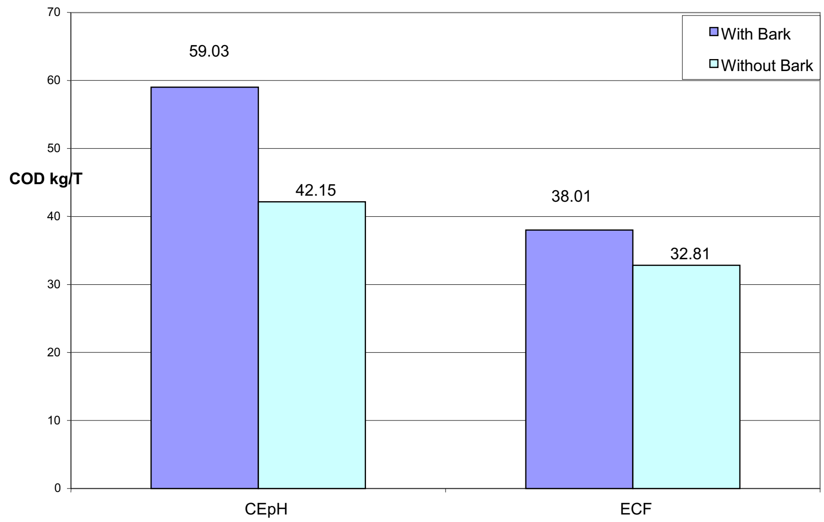

Fig 3 Effect of bark on ECF Bleach effluent TDS

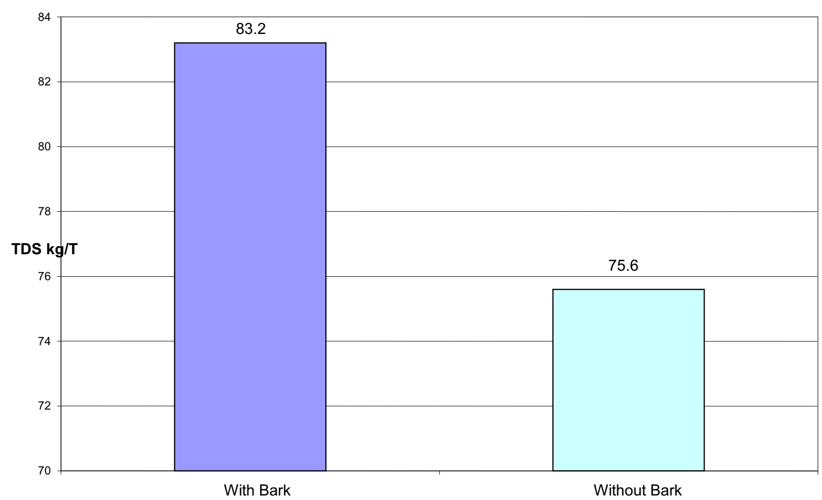

Fig 4 Effect of bark on PC number of bleached pulp