Hydrogen peroxide bleaching of eucalyptus chemimechanical pulp

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ABSTRACT

Hydrogen Peroxide is a lignin preserving bleaching agent employed for bleaching of mechanical as well as chemical pulps. However, it is not being used in India for pulp bleaching because the domestic production is not sufficient to meet the requirement and it is very expensive.

Bleaching by hydrogen peroxide is through the perhydroxyl ions formed by its dissociation. The brightnening of the pulp by hydrogen peroxide depends upon the raw material, pulping process used, the presence of the metallic ions and process variables like pulp consistency, peroxide concentration, alkalinity, temperature and retention time. The effect of these variables is discussed in the present paper. If these variables are not properly controlled, hydrogen peroxide may give the undesired decomposition liberating oxygen gas. This can be avoided by chelating the metal ions and also using some stabilizer. Sodium silicate along with magnessium sulphate can work as excellent stabilizer under the bleaching conditions.

Due to the problems experienced in using calcium hypochlorite for bleaching chemimechanical pulp for its newsprint production, Hindustan Newsprint Limited (HNL) has switched over to the hydrogen peroxide bleaching of its Chemi-mechanical pulp since October 1990. The existing system for calcium hypochlorite bleaching has been adopted for the peroxide bleaching only with minor modifications.

As the system was not suitable for two stage bleaching with peroxide, single stage bleaching is carried out. The peroxide consumption is found to vary from 2.25% to 3.75% based on O.D. pulp depending upon the type of wood to achieve a brightness of 50-52% for bleached pulp. Recirculation of back water at various positions helps in effective utilisation of the peroxide charge for the brightness development. Use of peroxide bleaching has also eased the situation on the effluent load with respect to suspended solids, BOD COD discharge.

The quality of the peroxide bleached pulp is found to be superior over the calcium hypochlorite bleached pulp with respect to runnability on paper machine. The productivity has also improved due to the elimination of shut down time which otherwise were required with the calcium hypochlorite bleached pulps. Hydrogen peroxide bleaching is found to be a better method for bleaching of chemimechanical pulps. Eventhough the peroxide bleaching is costlier, HNL is able to adopt it due to the increased productivity achieved.

INTRODUCTION :

Hydrogen peroxide is an oxidant employed as a bleaching agent in wide range of industrial applications and is of major importance in the bleaching of textiles and wood pulps. When applied under relatively mild conditions, hydrogen peroxide is a very effective lignin preserving bleaching agent, improving the brightness of lignified pulps without significant shrink-

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age in yield and very little damage to the pulp fibres. (1) All over the world the mechanical pulps are bleached with hydrogen peroxide inspite of its higher cost.

Hydrogen peroxide bleaching of mechanical pulp started first at St. Regis Paper Company in 1941 for the bleaching of stone ground wood pulp (2) By the year 1960 there were over 50 mills using hydrogen peroxide to bleach the mechanical, cold soda, sulphite and even kraft pulps. Presently most of the pulp mills in Europe and America use hydrogen peroxide for the bleaching of mechanical pulps in single stage or in combination with sodium hydrosulphite in two stages. Hydrogen peroxide is also finding importance in the bleaching of other types of pulps specially in chlorine free bleaching since the awareness towards AOX elimination has gained momentum.

In India hydrogen peroxide bleaching is mainly limited to the textile industries. Inspite of the known advantages, it has not been adopted in the bleaching of pulps due to two reasons first it is not readily available and second due to its exhorbitantly high cost. Until 1988 there was only one manufacturer of hydrogen peroxide in the country and the production of this unit was not sufficient to make it available for the pulp and paper industries. Even the newsprint mill which was designed for hydrogen peroxide bleaching of its bagasse mechanical pulp had to import hydrogen peroxide for its consumption. The second manufacturing unit that started in 1988 was for 100% export and was not available for domestic consumption The position slightly improved when the first unit went for an expansion doubling its capacity somewhere in 1987-88.

At Hindustan Newsprint Limited, the 220 BDMT per day mechanical pulp mill was designed for the bleaching of its eucalyptus chemimechanical pulp with two stage calcium hypochlorite. However, the actual operation of this bleaching process resulted in pulps having higher ash content to the extent of 2 5–3%. The calcium soaps were getting deposited in the various equipments as well as on the wire and felts of the paper machine resulting in loss of production due to paper breaks due to the presence of stickies as well as time loss for the cleaning.

Initial laboratory trials in replacing a part of calcium hypochlorite with hydrogen peroxide in one stage of bleaching did not yield encouraging results. Further, extensive research work was undertaken in collaboration with the scientists from National Peroxide Limited Bombay to completely replace the calcium hypochlorite with hydrogen peroxide to enable to switch over to hydrogen peroxide bleaching. This paper gives the details of this laboratory study as well as of plant experience in adopting the hydrogen peroxide at Hindustan Newsprint Limited for the bleaching of its chemimechanical pulp.

Hydrogen Peroxide Bleaching at Hindustan Newsprint Limited

As has been indicated earlier, the 220 BDMT per day chemimechanical pulp mill at Hindustan Newsprint Limited was designed for two stage calcium hypochlorite bleaching. The chmeimechanical pulp is produced from eucalyptus grandis and eucalyptus hybrid wood in varying admixture depending upon availability. The pulp is produced by chemi mechanical pulping process and the bleaching is carried out after the second stage of refining and washing of the unbleached pulp. 14-16% of calcium hypochlorite was added as available chlorine with 10–12% in the first stage and balance 2-4% in second stage without any washing in between. The bleached pulp is washed on a single stage drum washer and subjected to post refining before screening, cleaning and thickening of is for making it ready to use on the paper machine.

The calcium hypochlorite bleaching was increasing the pulp brightness from 26-28% to 50-52%. However, the resin and pitch in the pulp were combining with thecalcium ions in the bleach liquor to precipitate the calcium soap on the fibres. This was increasing the ash content of the bleached pulp to 2.5-3.0%. This high ash content in the pulp originating from the calcium soap was leading to various process problems in the pulp mill as well as on paper machine. The calcium soap was getting deposited on the various pipes and equipments in pulp mill and paper machine necessiating its frequent stoppage for cleaning and subsequent loss of production. This was also getting deposited on the sector sleeves of the disc save all reducing its filtering efficiency and overall fibre recovery efficiency resulting in higher fibre losses. The calcium soaps were also clogging the paper machine felts and wires which was not only causing frequent paper breaks, but also the machine was to stopped freqently for cleaning resulting in loss of production. The calcium hypochlorite bleaching was also degrading the already weak mechanical pulp fibres resulting in loss of strength necessiating higher requirement of costly chemical pulp component in the pulp furnish. Thus, though the use of calcium hypochlorite for the bleaching of the chemimechanical pulp was giving the desired brightness it was responsible for the overall lower productivity.

Attempts to eliminate the precipitation of calcium soap in the pulp fibres did not give encouraging results. The use of sodium hypochlorite though partially could reduce the problem, the cost of bleaching increased enormously due to the high cost of caustic soda making it uneconmical.

Laboratory Experiments on Hydrogen Peroxide Bleaching

Extensive studies were taken up at the mill laboratory to adopt the hydrogen peroxide bleaching for the mechanical pulp. Initial trials were not at all encouraging Replacing the calcium hypochlorite partly by hydrogen peroxide was not effective in eliminating the precipitation of the calcium soaps. Also, the response of hydrogen peroxide in brightening the partially calcium hypoclorite bleached pulp was poor. Attempts to completely replace the calcium hypochlorite by hydrogen peroxide was increasing the peroxide consumption and overall bleaching cost making it uneconomical for adopting in practice.

Generally, wherever hydrogen peroxide is used for the bleaching of softwood mechanical pulps, the brightness improvement is brought about by about 10 point raising it from 50-55% to 60-65%. However, the initial brightness of eucalyptus chemimechanical pulp produced at HNL was only 26-28% and improving it to 50-52% with economical charge of hydrogen peroxide was really a challenging task. Major emphasis was given in optimising the reaction conditions to eliminate the cost of unnecessary chemicals and to reduce the charge of hydrogen peroxide to avoid its decomposition by its better stabilisation.

The unbleached eucalyptus mechanical pulp produced at Hindustan Newsprint Limited was found to contain the transitional metal elements responsible for the decomposition of hydrogen peroxide only in trace quantities and it was found that the treatment of this unbleached pulp with chelating compounds for completing the metal ions was not necessary. This eliminated the use of costly metal chelating compound in the bleaching process. The quality of sodium silicate used as a stabiliser was also properly selected not to introduce any transitional metal ions to the system. Strict quality control over sodium silicate procurement is exercised to take care of this.

Eventhough use of higher quantity of sodium silicate was bringing about better stabilisation of hydrogen peroxide and brightness gain, it was adding to the cost of bleaching. Use of Epsom Salt ($MgSO_4$ $7H_6O$) was resorted to reduce the sodium silicate consumption to the optimum level. It was found by carrying out a number of experiments that the sodium silicate can be optimised at 3.5—4% when used in combination with Epsom salt at a dose of 0.05to0 10%. The alkalinity was maintained at the optimum level to reduce the consumption of caustic soda and thus reduce the overall bleaching cost. The alkalinity due to the use of sodium silicate was also taken into account in fixing the dose of sodium hydroxide. The initial pH was maintained at 10.5 by using about 1.24% sodium hydroxide with 2.0% sodium silicate of 38°Be which was dropping to about 9.0 after the first stage. This was again increased to 10.5 by using about 1.8 - 2.0% sodium hydroxide with another 1.5% of sodium siliscate in the second stage and the final pH was allowed to drop to about 10.0. Thus, the overall consumption of caustic soda was 3.0 — 3.2% and sodium silicate 3.5%. It should be borne in mind that 33 - 35% of the total peroxide bleaching cost is due to the other chemical like sodium silicate, sodium hydroxide, magnessium sulphate and sulphuric acid and hence [illegible] control over the usage of these chemicals can help in reducing the overall bleaching cost.

As has been mantioned earlier, the peroxide dose was optimised in two stages in the laboratory bleaching experiment. The H_2O_2 dosage in first stage was optimised at 2.25% (100% basis) and was varried as 0.5% and 0.75% in the second stage, thus bringing the total charge to 2.75 to 3.0%. The temperature of bleaching was optimised at 70°C and the retention time 90 minutes in first stage and 60 minutes in second stage. The consistency was maintained at 10% in the beginning of first stage which slightly dropped to 9.5% in the second stage. The pulp was diluted to 3.0% consistency at the end of bleaching and the pH was adjusted to 5.5 with sulphuric acid before the washing of these pulp. The bleaching experiments were carried out on unbleached pulp collected from the plant. The raw-material mix for the production of this unbleached pulp was 70% eucalyptus grandis and 30% eucalyptus hybrid. The conditions of hydrogen peroxide bleaching and the results are recorded in Table 1. Table II gives the strength and optical properties of the labora-

TABLE—I

LABORATORY BLEACHING OF UNBLEACHED CHEMIMECHANICAL PULP

Unbleached pulp brightness : 25.6%
Unbleached pulp pH : 8.6
Raw material Mix
Eucalyptus grandis : 70%
Eucalyptus hybrid : 30%

S.No.	Particulars	Unit	Results		
	Bleaching Sequence		H—H	P—P	P—P
	I Stage				
1.	Hypo added as available Cl	%	9.75	—	—
2.	Peroxide added as H_2O_2 (100%)	%	—	2.25	2.25
3.	Magnesium Sulphate	%	—	0.05	0.05
4.	Sodium Silicate (38°Be)	%	—	2.0	2.0
5.	Caustic as NaOH	%	0.77	1.24	1.24
6.	Consistency	%	10.0	10.0	10.0
7.	Retention time	Min	60	90	90
8.	Temperature	°C	40	70	70
9.	Initial pH	—	10.5	10.5	10.5
10.	Final pH	—	7.6	9·1	9.2
	II Stage				
11.	Hypo added as available Cl_2	%	3.0	—	—
12.	Peroxide added as H_2O_2 (100%)	%	—	0.5	0.75
13.	Magnesium Sulphate	%	—	0.05	0 05
14.	Sodium Silicate (38°Be)	%	—	1.5	1.5
15.	Caustic as NaOH	%	0.4	1.84	1.98
16.	Consistency	%	8.8	9.5	9 5
17.	Retention time	Min	60	60	60
18.	Temperature	°C	40	70	70
19.	Initial pH	—	9.6	10.5	10 5
20.	Final pH	—	7.3	10.2	10.2
21.	Residual Cl_2/H_2O_2	%	0.01	0.29	0.34
22.	H_2O_2 Consumed (To adjust pH to 5.5 at 3.0% cy)	%	—	3.37	3.50
23.	Shrinkage in bleaching	%	4.0	2.5	2 5
24.	Brightness of bleached pulp	%	50.9	48.2	49.9
25.	Yellowness	%	42.8	42.9	42.8
26.	P. C. Number	—	8.1	1.5	1.4
27.	Ash in bleached pulp	%	2.8	0.8	0.8
28.	Pitch in bleached pulp (Ether alcohol extractives)	%	1.72	1.17	—

tory bleached pulps. The pulp was also bleached by two stage hypochlorite and the results are included in Table I and II for comparison.

Discussion of Results of Laboratory Scale Blecaching

Laboratory experiments indicated that it is possible to bleach eucalyptus chemimechanical pulp to a brightness of 48—50% using hydrogen peroxide charge of 2.75 to 3.0% in two stages, with 2.25% in the first stage and balance in the second stage. The 2.75 to 3.0% application of hydrogen peroxide was improving the brightness by 21-24 points. Increasing the peroxide charge further in either of the stages did not improve the brightness appreciably.

The shrinkage of pulp in hydrogen peroxide bleaching is only 2.5% against 4.0% in calcium hypochlorite bleaching which means that there is a net gain of about 1% bleached pulp yield with hydrogen peroxide bleaching. Eventhough no appreciable improvement in yellowness could be seen in the hydrogen peroxide bleached pulp over calcium hypo bleached pulp, there was an improvement in PC number from 8.1 for hypo bleached pulp to almost 1.5 for peroxide bleached pulp. This shows the brightness stability of the peroxide bleached pulp due to which it is even possible to maintain the brightness of peroxide bleached pulp lower by about 2 points to get the same brightness for the final newsprint. The most appreciable point with hydrogen peroxide bleaching is the reduction in the ash content of the bleached pulp from 2 8% in case of hypo bleached to 0 8% in case of peroxide bleached pulp. The pitch content (ether alcohol extractives) is also reduced by about 0.5% i. e. from 1 72% for calcium hypo bleached pulp to 1.17% for peroxide bleached pulp. As regards the properties of the pulps, there is a considerable improvement in the wet web strength by more than 10% in peroxide bleached pulp over calcium hypo bleached pulp. There is an improvement of 2-6% in the strength properties like breaking length, burst factor and tear factor. The opacity of the pulp is also improved by about 2 percent.

TABLE—II

STRENGTH AND OPTICAL PROPERTIES OF LABORATORY BLEACHED CHEMIMECHANICAL PULPS

S.No.	Particulars	Units	Results		
1.	Bleaching Sequence	—	H—H	P—P	P—P
2.	Bleaching Chemical Cl_2/H_2O_2	%	12.75	2.75	3.00
3.	Initial freeness	ml CSF	500	470	470
4.	Final freeness	ml CSF	200	200	200
5.	Beating time	min	29.0	23.8	22.6
6.	Drainage time	sec.	6.5	6 7	6.7
7.	Wet web strength	9/30mm	156	172	177
8.	Basis weight	9/m²	52.1	51.7	52.4
9.	Bulk	cm³/g	1.83	1 84	1.80
10.	Breaking length	m	4770	5060	4890
11.	Stretch	%	3.2	3.1	2 7
12.	Tear Factor	—	50.5	54.1	53.5
13.	Burst Factor	—	28.4	29 0	28 6
14.	Folding Endurance	D.F.	23	21	19
15.	Porosity (Bendtsen)	ml/min	753	595	622
16.	Brightness	%	49.8	48 2	49.9
17.	Opacity	%	88 3	90.2	90 3
18.	Yellowness	%	42.8	42.9	42.1
19.	Light scattering coefficient	m²/kg	43 2	41.2	42.5

Plant Scale Trials of Hydrogen Peroxide Bleaching :

Encouraged by the convincing results obtained in the Laboratory with hydrogen peroxide bleaching of chemimechanical pulps, a short plant scale trial for a period of 3 days was planned in the plant. The trial was jointly organised by HNL and National Peroxide Limited to confirm the results obtained in the laboratory. On the plant scale the existing calcium hypochlorite bleaching system consisting of pulper, hypo mixer, the two retention towers and the refiner stock chest were utilised for the peroxide bleaching with only minor modifications for the dosing of peroxide and the other chemicals.

In the chemimechanical pulp mill the alkali impregnated eucalyptus chips after refining in two stages on RL 58 raffinators, the unbleached pulp is washed on a single stage drum washer. The calcium hypochlorite and caustic are added at the repulper and passes through a mixer before falling into a downward flow bleach tower at about 10% consistency. After a retention time of about 100 minutes in this tower, the pulp is diluted to about 3.5% consistency and the additional quantity of hypo and caustic required is added before pumping it into the upward flow second retention tower with a retention time of about 40 minutes. The pulp from this second tower overflowing at the launder is washed over the bleach washer. The washed pulp is refined in a third raffinator from where it falls into a stock chest. From this stock chest, it is sent for cleaning, screening and thickening.

The above mentioned system was as such utilised for the Hydrogen peroxide bleaching. The initial trails were with two stage peroxide addition as developed in laboratory- Sodium silicate. caustic soda and magnessium sulphate after diluting to the required concentration were pumped to the repulper at one end and hydrogen peroxide to the discharge end of the repulper. The charge of hydrogen peroxide was 2.25% (on 100% basis), sodium silicate 2% (38°Be), sodium hydroxide 1.5% and magnessium sulphate 0·05%. The actual mixing is taking place in the mixer where LP steam is also given to heat the pulp to 70°C. This pulp then falls into the 1st retention tower at 10% consistency which provides a retention time of 100 minutes. The pulp is drawn from the bottom of this tower after providing ring dilution and the hydrogen peroxide and other chemicals for the second stage added at the suction of the pump; pumping the pulp to the second retention tower. Hydrogen peroxide added was 0.75% (100% basis), sodium silicate 1.5% (38°Be), Sodium hydroxide 0.5% and 0.05% magnessium sulphate at this point. The consistency of the pulp was dropping to 3.5% and the temperature to 50-55°C. No heating is done at this point and the pulp travels upward in the second tower which provides about 40 minutes retention time. The pulp overflowing from this tower at the launder is diluted to 1.0—1.5% consistency and washed over the bleach washer. The washed pulp is refined in a third stage raffinator. The discharge from this raffinator fall into a refiner stock chest at 3.5% consistency. The pulp is acidified to a pH of 5.5 with dilute sulphuric acid. The acidified pulp is screened, cleaned and thickened on a disc filter before putting it into the high density storage chest for drawing on paper machine.

In the above bleaching trials, it was possible to achieve the brightness for the bleached pulp around 50 0% with a total peroxide charge of 2.75—3 0% on 100% basis). The peroxide consumption was almost 90% at the end of first stage where the conditions for the reaction were ideal. However, the reaction conditions eapecially with respect to temperature and consistency were not ideal in the second stage. Due to this, it was found that sometimes the alkali darkening was taking place in the second stage reverting the brightness below 50%. The consumption of hydrogen peroxide in the second stage was also low and 50—60% of it was remaining as residual. All this gave an indication that due to unsuitable conditions, the second stage was not contributing to brightness improvement whereas it was damaging the brightness already gained in the first stage due to alkali darkening. Hence, it was decided to abandon this second stage and adopt only single stage in future trials.

Single stage peroxide bleaching :

As the available bleaching system at Hindustan Newsprint Limited was not suitable for a second stage bleaching of hydrogen peroxide, and also designing one, involved a number of capital equipments and major modifications it was dceided to go for single stage peroxide bleaching to get the maximum effect with the available equipments.

In the single stage bleaching, the entire dose of hydrogen peroxide and the other chemicals was charged at the repulper of unbleach washer. On the basis of the continuous use, it is seen that the charge of hydrogen peroxide varies depending upon the type of wood i e whether it is hybrid, grandis or their mixture. However, the requirement of other chemicals remains more or less conctant, with sodium silicate 3 5% (38°Be) sodium hydroxide 1.3—1.6% and magnessium sulphate 0 05%. The initial pH is maintained at 10.3±1 and the pulp is heated to 73—75°C at the mixer with LP steam Retention of 100 minutes was provided in the downward flow first tower at 10% consistency. At the end of the first tower 75—88% of the peroxide charge is getting consumed.

The pulp from the first retention tower is diluted at the ring with the filtrate from the bleach washer to a consistency of 3.5% and then pumped to the second retention tower which only provides a retention time of 40 minutes. No chemicals nor hydrogen peroxide is given at this stage. Only peroxide left at the end of the first stage retention and that introduced through the recirculation of the bleach washer filtrate react with the pulp in the second retention tower increasing the brightness by about 2 units. This has completely eliminated the alkali darkening of the pulp which was taking place otherwise.

TABLE—III

PLANT SCALE HYDROGEN PEROXIDE BLEACHING OF EUCALYPTUS CHEMIMECHANICAL PULP

Sl.No.	Particulars	Units	Results		
1.	Raw Material				
	Eucalyptus grandis	%	100	—	70
	Eucalyptus hybrid	%	—	100	30
2.	Unbleached pulp brightness	%	2.70	26.0	27.0
	I Stage				
3.	Hydrogen Peroxide (100%)	%	2.22	3 74	2.78
4.	Sodium Silicate (38°Be)	%	3.5	3.5	3.5
5.	Sodium Hydroxide	%	1.50	1.55	1.30
6.	Magnesium Sulphate	%	0.05	0 05	0.05
7.	Consistency	%	9-10	9-10	9-10
8.	Temperature	°C	74	75	73
9.	Retention time	min	100	100	100
10.	Initial pH	—	10 2	10 2	10 5
11.	Final pH	—	8.4	8.4	8.7
	II Stage				
12.	Hydrogen Peroxide	%	NIL	NIL	NIL
13.	Sodium Silicate	%	NIL	NIL	NIL
14.	Sodium Hydroxide	%	NIL	NIL	NIL
15.	Magnesium Sulphate	%	NIL	NIL	NIL
16.	Consistency	%	3.5	3.5	3.5
17.	Temperature	°C	51	51	76
18.	Retention time	min	40	40	40
19.	Bleached pulp brightness	%	51.9	50.8	50.7
20.	Bleached pulp opacity	%	90.9	92.0	91.7

Even though 15—25% of the hydrogen peroxide was left over as residual at the end of the first retention tower, this was further utilised in the second stage retention. The residual peroxide at the end of the second stage retention, coming into the bleach filtrate is also utilised by its recirculation in the ring dilution at the outlet of the first retention tower as well as using this filirate on the unbleach washer spray for the washing of unbleach pulp This has not only resulted in the increase of the unbleached pulp brightness by 1—2 units, it also helps in heating of the unbleached pulp thus reducing the steam consumption for the subsequent heating of the pulp at the mixer.

The bleaching conditions adopted for the hydrogen peroxide bleaching of eucalyptus grandis and hybrid pulp individually and in the admixture of 70:30 is given in Table III. The average strength and optical properties for the pulps obtained as above are given in Table IV. The strength and optical properties for the chemimechanical pulp produced by 70% eucalyptus grandis and 30% eucalyptus hybrid and bleached using calcium hypochlorite in the plant are also included in this table for comparison.

TABLE – IV

STRENGTH AND OPTICAL PROPERTIES OF PLANT SCALE BLEACHED EUCALYPTUS MECHANICAL PULPS

Sl. No.	Particulars	Units	Results			
1.	Rawmaterial					
	Eucalyptus grandis	%	100	—	70	70
	Eucalyptus hybrid	%	—	100	30	30
2.	Bleaching sequence	—	P	P	P	H-H
3.	Freeness	ml CSF	240	240	230	220
4.	Ash	%	0.77	0.76	0.70	2 51
5.	Bauer Mc Nett fibre classification					
	+ 30	%	1.2	0.1	3 1	0.6
	— 30 + 50	%	37.4	30.6	42.7	36 0
	— 50 + 100	%	27.4	28.0	23 3	23 6
	—100 + 200	%	13 5	13.7	11.4	12 8
	— 200	%	20.5	27.6	19.5	27 0
6.	Wet web strength	g/30 mm	125	80	114	102
7.	Basis weight	g/m²	52.0	51.8	50.7	52.0
8.	Bulk	cm³/g	2.15	2.39	2 30	2 03
9.	Breaking length	m	3710	2480	3250	3150
10.	Tear Fatcor	—	40.2	27.9	39 9	38 9
11.	Burst Factor	—	15.1	9.4	16 5	15.5
12.	Porosity (Bendtsen)	ml/min	1296	2246	1948	1966
13.	Brightness	%	51.9	50.8	50 7	50 9
14.	Opacity	%	90 9	92.0	91.7	89 6
15.	Yellowness	%	38.0	39.0	38.0	38 5

Discussion of results of Plant scale Hydrogen peroxide bleaching :

The two stage peroxide bleaching as optimised in the laboratory could not be adopted in the plant scale due to the non-suitability of the equipment available in the plant. The bleaching was suitably modified as single stage with extended retention in the second retention tower to suit the available equipments in the plant. It has been observed that the bleaching response with hydrogen peroxide is better in the plant than in the laboratory. This is mainly due to the direct heating of the pulp with steam to achieve the desired reaction temperature as well as the closed towers available in the plant. Such conditions could not be simulated in the laboratory. Another advantage in the plant scale bleaching is the recirculation of the bleach filtrate for dilution as well as for the washing of the unbleached pulp. Because of this, even though, 15—25% of the hydrogen peroxide charge was left as residual at the initial stage, the ultimate loss of hydrogen peroxide going into the effluents was almost negligible. This has helped in the complete utilisation of the peroxide in the bleaching. The recirculation of the bleach filtrate has helped in improving the overall brightness by about 3—4 units.

Experiences of the plant scale hydrogen peroxide bleaching of grandis and hybrid varieties of eucalyptus wood pulp has shown that the pulp from hybrid variety is more difficult to bleach and the response to brightness development is poor and the peroxide requirement is high whereas the pulp from grandis variety is easy to bleach and the peroxide consumption is also low. It may be seen that to achieve the same level of brighness, the peroxide requirement for the pulp from hybrid variety is about 70% more than that required by the grandis variety. Study of the strength properties of the bleached pulps given in the Table IV indicate that the bleached pulp from eucalyptus grandis is superior to hybrid which is the case even with calcium hypo bleached pulps. However, hydrogen peroxide bleaching definitely helps in improving the quality of the pulp as can be seen by comparing the results for the pulp with 70% grandis and 30% hybrid given in Table IV separately for peroxide bleached and calcium hypo bleached. Hydrogen peroxide bleaching makes the pulp fibres more flexible making the post refining more meaningful. It may be seen that the fines in the final pulp measured as −200 fraction is reduced from 27% for hypo bleached pulp to 19.5% for peroxide bleached pulp. The reduction of fines has a definite role in improving the runnability of the peroxide bleached pulp on the paper machine and the requirement of chemical pulp component in the furnish. Marginal but definite improvements in the wet web strength as well as dry strength like breaking length, burst factor and tear factor and also in the opacity values be observed for the peroxide bleached pulps over the calcium hypo bleached pulps. Above all there is a considerable decrease in the ash content of the peroxide bleached pulps.

Performance of Hydrogen Peroxide Bleached Pulps

Eventhough, the cost of bleaching of chemimechanical pulp has gone up by almost 100% with hydrogen peroxide bleaching, Hindustan Newsprint Limited is able to adopt this bleaching process considering the overall benefits and improvement in productivity. The machine runnability has improved due to the less number of breaks as well as reduction in the loss of production due to the stopping of paper machine for felt and wire cleaning. The paper machine could also be stabilised at a higher speed due to the better runnability of the pulp. The elimination of ash in the pulp due to the precipitation of calcium soap has eliminated the formation of hard deposits on the equipments and pipe line. This has eliminated the formation of deposits on the sector sleeves of the disc save all thus improving the performance of saveall for fibre recovery. This in turn has reduced the fibre loss considerably. Improvement of the quality of the mechanical pulp and its better runnability on paper machine has paved the way to reduce the costly chemical pulp component in the furnish and reducing the overall cost of production of newsprint.

Environmental Considerations

Though environmental aspects were not of major consideration in adopting hydrogen peroxide bleaching, it has eased the situation. The various discharges from the chemimechanical pulp mill with hydrogen peroxide and calcium hypochlorite bleaching are given in Table V.

The process of producing unbleached pulp more or less remains same irrespective of the bleaching chemical used except for some changes taking place due to the recirculation of back water from bleach section into the unbleach section when hydrogen peroxide is used. Accordingly, the effluent discharge from unbleach section almost remains same with both hydrogen peroxide as well as calcium hypo chlorite bleaching. However, considerable reduction in the discharges is taking place from the bleach section when hydrogen peroxide is used as a bleaching chemical. This results in the reduction of the overall discharges from the chemimechanical pulp mill as can be seen from Table V. The quantity of

TABLE—V

EFFECT OF HYDROGEN PEROXIDE BLEACHING ON EFFLUENT DISCHARGE

Si.No.	Paramerers	Units	Hydrogen Peroxide Bleaching	Calcium Hypochlorite Bleaching	Reduction %
1.	Effluent Flow	m^3/Hr	389	441	11.8
2.	Suspended solids	mg/lit	610	961	36.5
3.	Colour	Pt-co units	5920	6170	4.1
4.	COD	mg/lit	2480	3050	18.7
5.	BOD	mg/lit	780	1170	33.3

effluent is reduced by 11.8%, suspended solids by 36.5%, colour by 4.1%, COD by 18.7% and BOD by 33.3%. The reduction in the quantity of the effluents is due to the recirculation of the bleach section back water adopted with hydrogen peroxide bleaching. The reduction in suspended solids is mainly due to the reduction in the fines fraction in the hydrogen peroxide bleached pulp which otherwise produced find their way into the effluents. Though the reduction in colour discharge is only marginal, considering the better shade of the hydrogen peroxide bleached pulp, the excess colour extracted in this case also gets reduced due to the bleaching action of hydrogen peroxide, thus not allowing to go up the colour discharge. The decrease in the COD and BOD discharge may be correlated to the increased yield of bleached pulp with hydrogen peroxide bleaching.

Hydrogen peroxide bleaching has helped in eliminating the chlorine, making the bleaching chlorine free. Though the estimation of the chlorinated organic compounds (AOX) could be carried out, the AOX discharge gets completely eliminated with hydrogen peroxide bleaching.

Conclusions

Hydrogen peroxide bleaching is a better method of bleaching the chemimechanical pulp. Though it increases the cost of bleaching considering the overall benefits it works out to be more productive.

At Hindustan Newsprint Limited, the originally designed calcium hyphochlorite bleaching system in the 220 BDMT per day chemimechanical pulp mill has been utilised for the hydrogen peroxide bleaching with only some minor modifications. Hindustan Newsprint Limited has switced over to the hydrogen peroxide bleaching since October 1990.

The results of hydrogen peroxide bleaching are very encouraging. There is improvement in the quality of the pulp and its runnability on paper machine. The problems experienced due to the pitch and stickies is totally overcome. Elimination of chlorine from bleaching and the AOX from the effluents is an added advantage of hydrogen peroxide bleaching.

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