Role of Hydrogen Peroxide For Enhancing The Brightness of Pulp at High Density Tower

Tendulkar S.R, Shinde J.K. & Mokashi A.G.

INTRODUCTION

The usual practice in a bleach plant is to control the slushed pulp brightness. However, the brightness of pulp often drops by one to several points by the time pulp is run over the paper machine and then even more before the paper reaches ultimate consumer. The problem of brightness reversion has been studied for a long time and its cause has been attributed to practically every component of pulp and paper including lignin, hemicellulose, oxidised cellulose, resin, metal ions present and paper additives such as rosin, alum, glue and starch (1).

The most of the paper mills in India follow old conventional bleaching process, i.e. CEHH for wood, bamboo chemical pulp and CEH for agro residue pulp e.g. bagasse rice straw etc. A lot of literature (2-11) has been published during last one and half decade on modification of these short sequences into CEpH and CEpHH by introduction of hydrogen peroxide at extraction stage. This CEpHH bleaching sequence has become very popular and it is now become a common feature in most of the Indian pulp/paper mills. No doubt, some of the market leaders have already switched over to usage of chlorine dioxide, oxygen and hydrogen peroxide by partially eliminating usage of elemental chlorine and/or hypochlorite. But, by and large, most of the paper mills still continue with conventional CEHH or CEpHH bleaching sequence. The most of the mills having old conventional bleaching sequence can not use either hydrogen peroxide or chlorine dioxide for bleaching due to design constraint of the towers/equipments. This inadequacy leads to many problems in small and medium size pulp/paper mill which are engaged in manufacture of writing printing paper by usage of chemical pulp.

The pulp bleached by short sequences CEHH or CEH (for agro residue) has residual chlorine. Inspite of thorugh washing, the traces of chlorine remain on the pulp. This residual chlorine is not only detrimental for mechanical properties, but it is also responsible for reversion of brigtness of pulp. Residual chlorine also imparts yellow tinge to the pulp and hence to the paper. Sometimes, the magnitude of reversion is very high. This presence of residual chlorine also leads to another problem at stock chest if it is not controlled properly. There is always headache to stock preparation manager about shade variations of pulp/ paper. A residual chlorine also reacts with optical brighner/tinting dyes, leading to variation in consumption of optical brightner/dyes etc. In practice, this residual chlorine passed over from final bleaching tower to H.D. Tower is removed by using chemicals merely act as antichlor but do not help to increase/ stabilise the brightness of pulp. These chemicals also increase TDS of the wash liquor. It is also found that hypochlorite bleached pulp after washing is slightly alkaline in nature (pH 7.5 to 8.5). This residual alkali is subsequently neutralised by alum at stock preparation stage to send acidic stock to paper machine. The effective utilisation of this residual alkali on the pulp is being carried out under ambient conditions to activate hydrogen peroxide in a controlled manner to generate perhydroxyl ions (HOO^-) for bleaching. While doing so, a part of hydrogen peroxide also acts as an antichlor and thus reversion due to residual chlorine is minimised. Thus, this dead time and also residual alkali is utilised to make additional attempts to bleach the pulp further and also to stabilise the brightness of pulp. Earlier, such attempts were

* National Peroxide Limited,
NRC Road, P.O. Mohone, Kalyan 421102,
Maharashtra, India
Fax No. 0251-546469

TABLE-1 BLEACHING CONDITIONS OF VARIOUS PULP SAMPLES

Sequence / Parameters	Bamboo				Bagasse			Rice Straw		
	C	E	H	H	C	E	H	C	E	H
1. Chlorine (A.C), % on OD Pulp	7	-	-	-	28	-	-	6.0	-	-
2. Caustic % -do-	-	3.75	-	-	-	2.0	-	-	3.5	-
3. Ca.Hypo (A.C.), % -do-	-	-	2.5	0.5	-	-	2.5	-	-	3.0
4. Consistency %	3.0	10	10	10	2.0	10	10	2.5	7	6
5. Temperature °C	Amb.	60	45	Amb.	Amb.	60	Amb.	Amb.	60	40
6. Retention Time, (min)	45	90	90	90	45	60	120	45	60	90

also reported (12-14) to stabilise the brightness of pulp by usage of hydrogen peroxide.

EXPERIMENTAL

The unbleached pulp samples of bagasse, rice straw and bamboo were collected from some of the leading paper mills for this study. The bamboo pulp was bleached by conventional CEHH as well as by CEpHH bleaching sequence to a final pulp brigthness level of 80^0 ISO. Rice straw and bagasse pulp were bleached by CEH and CEpH bleaching sequence to a final pulp brightness level of 80^0 ISO. Bleaching conditions of these pulp samples have been given in Table 1. In each case, the final bleached pulp was divided into five parts. The first part of the pulp was kept as a control and 0.05, 0.1, 0.15 and 0.2% H_2O_2 (100% basis) was added to the remaining four parts of bleached pulp respectively. All these pulp samples were kept at ambient temperature and at 10% consistency (simulation of H.D. tower conditions). From each set, the pulp samples were withdrawn after the duration of 2, 4, 6, 8, 10 and 24 hours and handsheets were prepared for brightness measurement.

Following H.D. Tower conditions were simulated in the laboratory for study:

pH	:	7.5-8.5
Temperature	:	Ambient
Consistency	:	10%
Duration in Hours	:	(2-10 at the interval of 2 hours and also 24 hours).

H_2O_2 (100%) Dosages : 0.05%-0.2% on O.D. Pulp.

TESTING

Brightness

The handsheets were dried in the air and their brightness values were measured on TECHNIBRITE Model TBIC at effective wavelength of 457 nm which gives the brightness values directly in ^{0}ISO.

Post Colour Number (P.C. NUMBER)

The natural ageing of pulp is very slow and not reproducible. Therefore, attempts have been made to speed up the ageing process by exposure of pulp samples to higher temperture. In our present study ageing was carried out in laboratory model steamer where 100°C temperature at 100% humidity was

TABLE 2A: H.D. Tower Simulation by Usage of H_2O_2 For CEHH Bleached-Bamboo chemical pulp

Parameters	Time Hrs.	Blank	P 0.05 %	P 0.1 %	P 0.15 %	P 0.2 %
Brightness °ISO	0	79.1	79.5	79.5	79.9	80.3
	2	79.7	79.6	80.0	80.3	80.5
	4	79.4	79.7	80.0	80.2	80.2
	6	79.4	79.7	80.0	80.4	80.6
	8	79.4	79.7	80.0	80.6	80.6
	10	79.2	79.7	80.1	80.4	80.6
	24	78.7	80.1	80.1	80.6	81.2
Post Colour Number	0	9.3	9.3	9.2	9.3	9.3
	2	9.4	9.0	9.1	9.2	9.3
	4	9.6	8.9	8.8	9.0	9.0
	6	9.1	8.5	8.2	8.9	9.0
	8	8.7	8.5	8.2	8.5	8.9
	10	8.6	8.5	8.0	8.4	8.9
	24	8.5	8.5	8.2	8.3	8.3

P-H_2O_2 (100%)

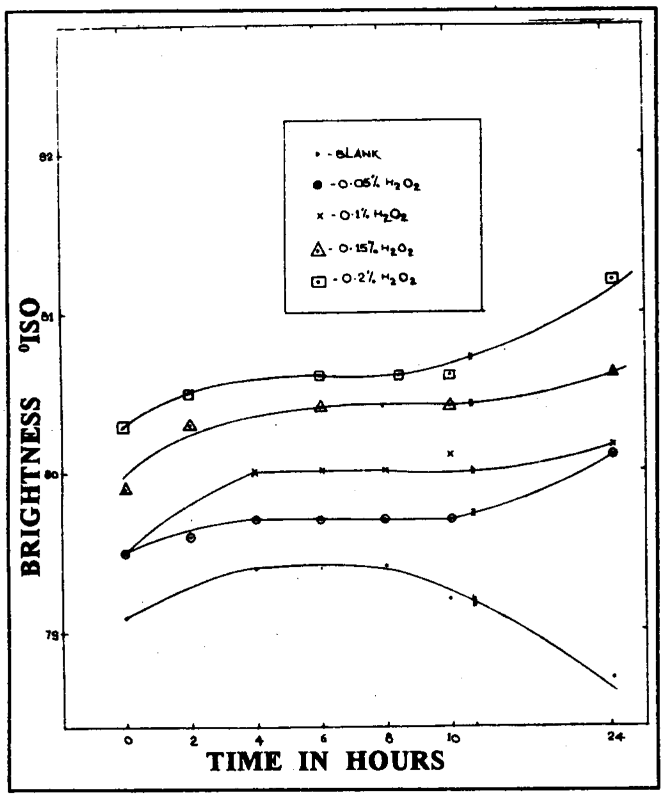

FIG.-1 BAMBOO PULP CEHH BLEACHED EFFECT OF H_2O_2 IN H.D. TOWER

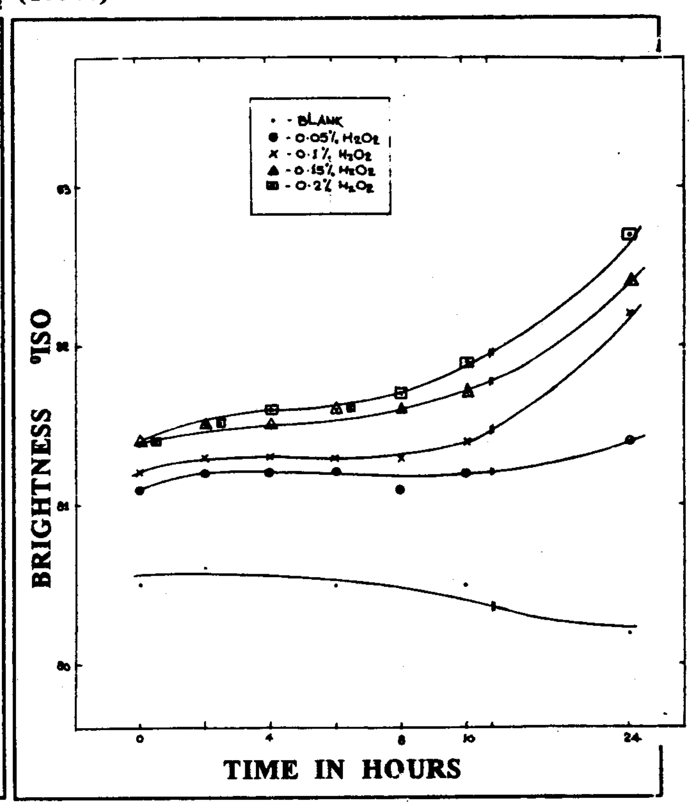

FIG.-2 BAMBOO PULP CEpHH BLEACHED EFFECT OF H_2O_2 IN H.D. TOWER

TABLE 2B: H.D. Tower Simulation by Usage of H_2O_2 For CEpHH Bleached-Bamboo chemical pulp

Parameters	Time Hrs.	Blank	P 0.05 %	P 0.1 %	P 0.15 %	P 0.2 %
Brightness ° ISO	0	80.5	81.1	81.2	81.4	81.4
	2	80.6	81.2	81.3	81.5	81.5
	4	80.4	81.2	81.3	81.5	81.6
	6	80.5	81.2	81.3	81.6	81.6
	8	80.4	81.1	81.3	81.6	81.3
	10	80.5	81.2	81.4	81.7	81.9
	24	80.2	81.4	82.2	82.4	82.7
Post Colour Number	0	6.1	5.9	5.9	5.9	5.8
	2	6.1	6.0	5.8	5.8	5.7
	4	6.0	5.7	5.6	5.6	5.5
	6	5.9	5.7	5.7	5.5	5.5
	8	5.8	5.7	5.8	5.6	5.2
	10	5.8	5.6	5.6	5.2	5.2
	24	5.6	5.2	5.0	5.0	5.0

P-H_2O_2 (100%)

TABLE 3A: H.D. Tower Simulation by Usage of H_2O_2 For CEH Bleached-Bagasse pulp

Parameters	Time Hrs.	Blank	P 0.05 %	P 0.1 %	P 0.15 %	P 0.2 %
Brightness ° ISO	0	82.2	82.1	82.6	82.7	83.1
	2	82.6	82.4	82.9	82.9	83.4
	4	82.7	82.7	82.9	83.0	83.5
	6	82.8	82.8	82.9	83.2	83.6
	8	82.9	82.8	83.0	83.3	83.6
	10	82.3	82.8	83.1	83.3	83.2
	24	82.0	82.6	82.8	83.1	83.0
Post Colour Number	0	3.68	3.37	3.79	3.49	3.54
	2	3.3	3.47	3.38	3.18	3.29
	4	3.3	3.09	3.08	3.08	3.08
	6	3.2	3.4	3.27	3.16	3.21
	8	3.27	3.31	3.20	3.10	3.12
	10	3.23	3.33	3.42	3.25	3.1
	24	3.20	2.98	3.11	3.15	2.9

P-H_2O_2 (100%)

TABLE 3B: H.D. Tower Simulation by Usage of H_2O_2 For CEpH Bleached-Bagasse pulp

Parameters	Time Hrs.	Blank	P 0.05 %	P 0.1 %	P 0.15 %	P 0.2 %
Brightness °ISO	0	80.5	80.4	80.8	80.5	80.9
	2	80.4	80.5	81.1	80.8	80.9
	4	80.4	80.5	81.1	80.8	81.0
	6	80.2	80.5	81.1	80.9	81.1
	8	80.4	80.5	81.0	81.1	81.3
	10	80.4	81.9	81.1	81.2	81.2
	24	80.0	81.0	81.2	81.4	81.3
Post Colour Number	0	3.3	2.9	2.9	2.8	2.9
	2	3.04	2.9	2.7	2.8	2.9
	4	2.98	2.8	2.7	2.7	2.8
	6	3.08	2.8	2.8	2.7	2.7
	8	3.02	2.9	2.8	2.7	2.8
	10	2.93	2.8	2.8	2.6	2.8
	24	3.1	2.7	2.7	2.6	2.7

P-H_2O_2 (100%)

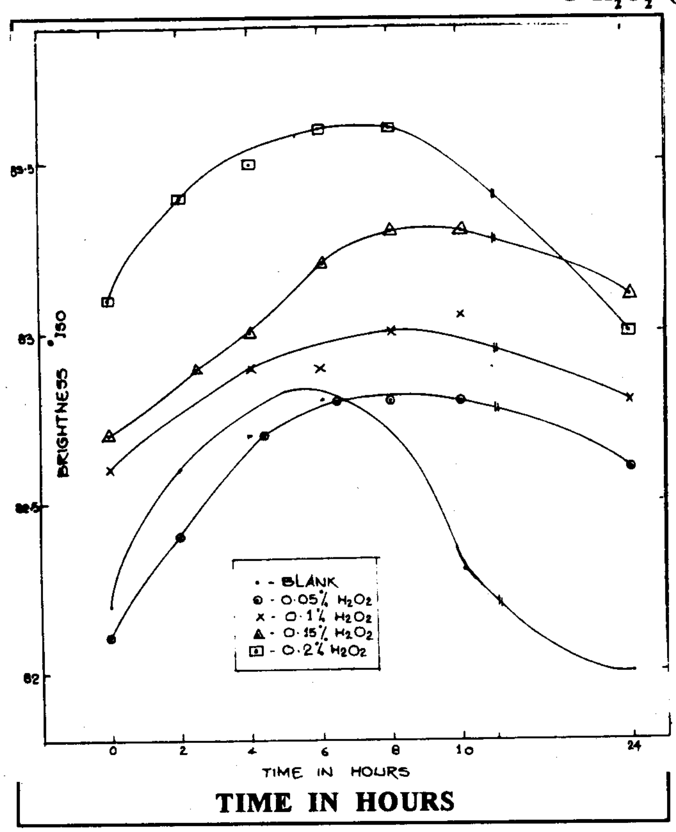

FIG.-3 BAGASSE PULP CEH BLEACHED EFFECT OF H_2O_2 IN H.D. TOWER

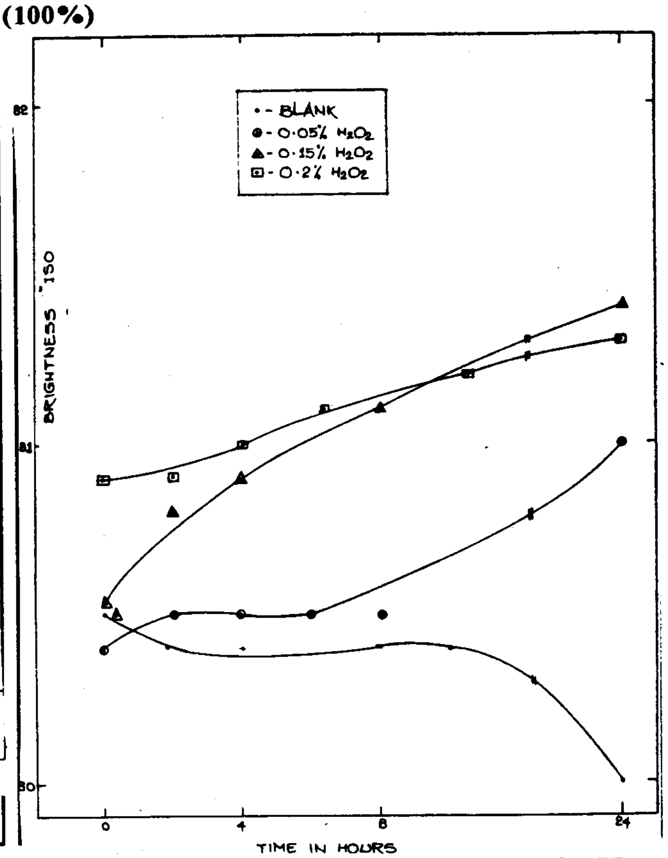

FIG.-4 BAGASSE PULP CEH BLEACHED EFFECT OF H_2O_2 IN H.D. TOWER maintained. As per TAPPI test procedure, the handsheets were kept under above conditions for one hour. The brightness values were measured again after ageing and post colour number was calculated by using the equations.

1. $\frac{K}{S} = \frac{(1-R)^2}{2R}$

2. P.C. No. = 100 X(K/S after ageing-K/S before ageing)

where K = Coefficient of absorption

S = Coefficient of scattering

R = Reflectivity = $\frac{\text{Brightness}}{100}$

RESULT & DISCUSSIONS

It can be seen from Table 2A & 2B and Fig.1 & 2 that by usage of 0.05 to 0.2% H_2O_2 (100%) on pulp the brightness of the pulp slowly increases. Whereas, in case of blank i.e. CEHH and CEpHH bleaching sequences, since chlorine based bleaching agent is used at final stage the brightness of pulp slowly decreases. Table 2A and 2B show the reverted brightness values of bamboo pulp which are 78.7° and 80.2° ISO for CEHH and CEpHH bleached pulp respectively after 24 hours. As against above, when 0.2% H_2O_2 (100%) is used at reverting were elevated to 81.2 and 82.7 °ISO respectively. This has clearly shown that hydrogen peroxide has not only stabilised the brightness but also helped to elevate the brightness.

Although, the bagasse pulp is easy to bleach, same trend like bamboo pulp has been observed. This is shown in Table 3A & 3B and Fig 3 & 4. The brightness values of pulp bleached by usage of H_2O_2 in H.D. tower got elevated in case of CEH and CEpH pulp to 83.0 and 81.3° ISO respectively as against the brightness values of these pulp get reverted in a corresponding period to 82.0 and 80.0 °ISO respectively.

Table 4A & 4B Fig. 5 & 6 show the trend of brightness values of rice straw pulp. In this case also, the brightness of pulp got reverted from 80.6 to 80.2° and from 80.1° to 79.4°ISO in case of CEH and CEpH bleached pulp. However, the same got elevated when 0.2% H_2O_2 (100%) was used at H.D. tower stage to

TABLE 4A: H.D. Tower Simulation by Usage of H_2O_2 For CEH Bleached-Rice Straw pulp

Parameters	Time Hrs.	Blank	P 0.05 %	P 0.1 %	P 0.15 %	P 0.2 %
Brightness ° ISO	0	80.6	80.8	80.7	81.1	81.3
	2	80.7	81.1	81.5	81.5	81.5
	4	80.6	81.3	81.6	81.6	81.7
	6	80.6	81.5	81.7	81.7	81.8
	8	80.5	81.6	81.7	81.8	82.3
	10	80.4	81.7	81.8	81.9	82.4
	24	80.2	81.6	82.0	82.0	82.6
Post Colour Number	0	3.96	3.71	3.74	3.79	3.78
	2	3.94	3.52	3.7	3.74	3.75
	4	4.04	3.57	3.67	3.65	3.62
	6	4.09	3.77	3.4	3.7	3.54
	8	4.08	3.62	3.4	3.6	3.46
	10	3.94	3.67	3.5	3.58	3.35
	24	3.9	3.6	3.4	3.4	3.2

P-H_2O_2 (100%)

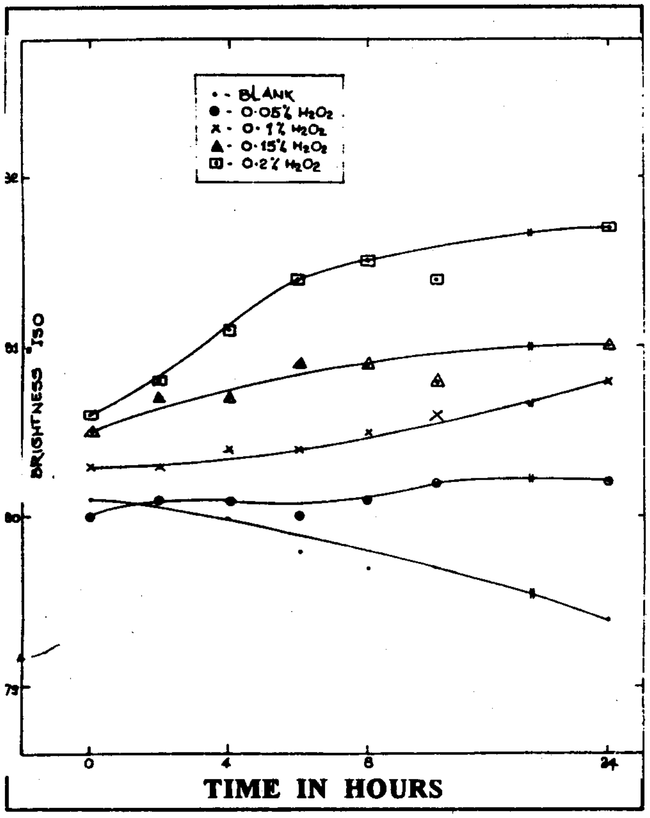

FIG.-5 RICE STRAW PULP CEH BLEACHED EFFECT OF H_2O_2 IN H.D. TOWER.

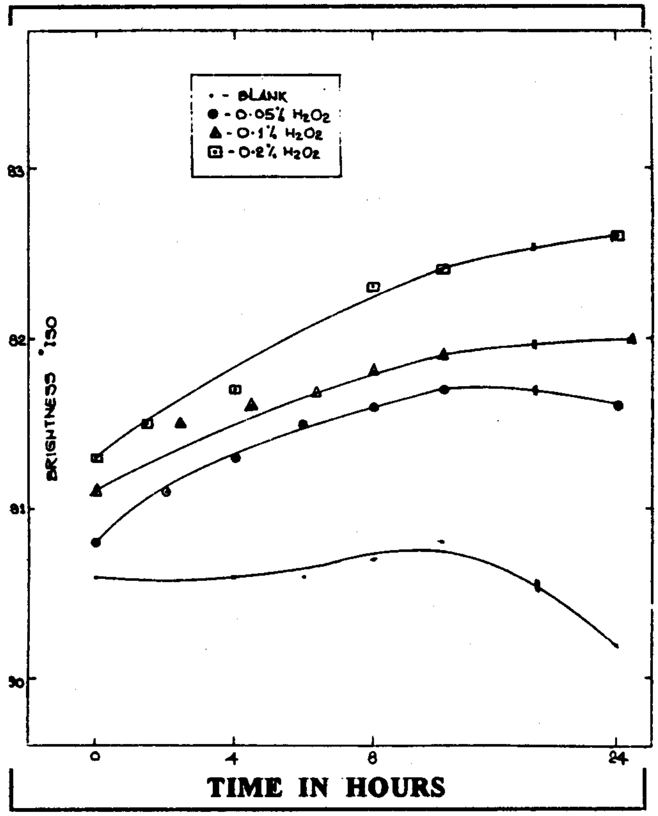

FIG.-6 RICE STRAW PULP CEpH BLEACHED EFFECT OF H_2O_2 IN H.D. TOWER.

TABLE 4B: H.D. Tower Simulation by Usage of H_2O_2 For CEpH Bleached- Rice Straw pulp

Parameters	Time Hrs.	Blank	P 0.05 %	P 0.1 %	P 0.15 %	P 0.2 %
Brightness °ISO	0	80.1	80.0	80.3	80.5	80.6
	2	80.2	80.1	80.3	80.7	80.8
	4	80.0	80.1	80.4	80.7	81.1
	6	79.8	80.0	80.4	80.9	81.4
	8	79.7	80.1	80.5	80.9	80.9
	10	79.7	80.2	80.6	80.8	81.4
	24	79.4	80.2	80.8	81.0	81.7
Post Colour Number	0	4.02	3.7	3.7	3.66	3.6
	2	3.9	3.61	3.42	3.7	3.6
	4	3.9	3.77	3.62	3.62	3.55
	6	4.04	3.5	3.75	3.68	3.6
	8	3.97	3.46	3.68	3.56	3.5
	10	3.73	3.45	3.62	3.5	3.4
	24	3.81	3.43	3.52	3.48	3.3

P-H_2O_2 (100%)

82.6 and 81.7 °ISO respectively.

It is also evident from Fig 7 and Table (2A to 4B) that P.C. values of pulp progressively decreases with increase in usage of hydrogen peroxide. This clearly states the stability of pulp increases with increase in usage of hydrogen peroxide. Hewever, usage of hydrogen peroxide (100%) during the study was restricted to 0.2% on O.D. pulp considering the constraints such as temperature and also, available alkalinity at H.D. tower stage.

CONCLUSIONS

Chemical pulp of bamboo, bagasse and rice straw after CEHH/CEH or CEpH/CEpHH bleaching if subjected for mild dosages of hydrogen peroxide in H.D. tower, the brightness value of pulp not only gets stabilised but it also gets elevated by 0.5 to 2° ISO depending upon the time.

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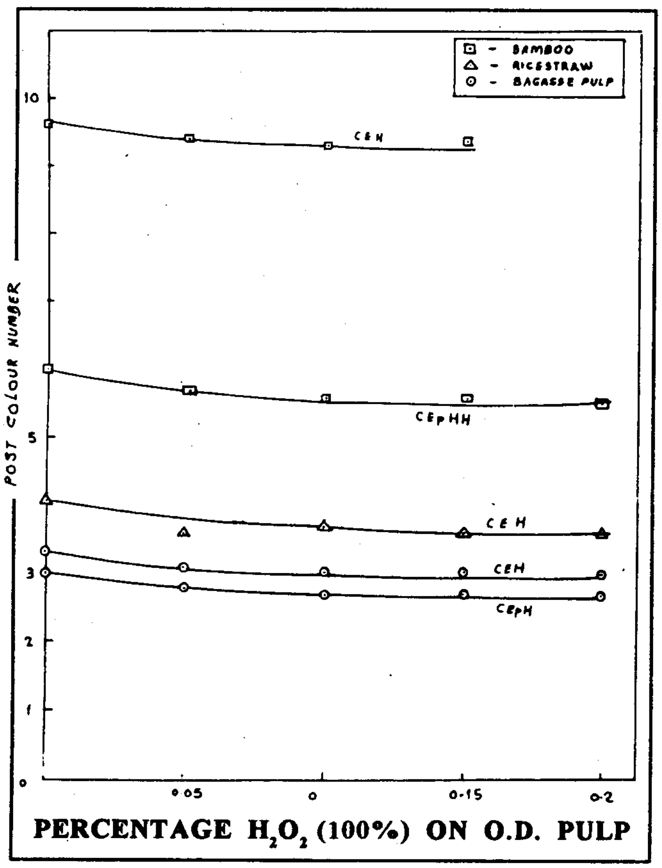

FIG.-7 EFFECT OF H_2O_2 ON POST COLOUR NUMBER OF BAMBOO, BAGASSE AND RICE STRAW PULP AFTER 4 HOURS RETENTION

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