Recycled Fibre Bleaching With Hydrogen Peroxide

Sridhar P., Reddy J.V.R., Venugopal C.S., Karmakar G.R.

ABSTRACT

Deinking process separates ink and fibres usually in alkaline conditions and requires the introduction of bleaching agent to improve the brightness. A study was carried out in the laboratory regarding the effect of Hydrogen Peroxide as a bleaching agent for various furnishes of recycled deinked washed pulp. Lab scale experiments can be useful for both research studies and for optimising the process in commercial scale. Furnish variation can also result in variation of brightness and yield.

INTRODUCTION

Waste Paper is an alternative raw material for manufacturing all types of paper. Demand for waste paper is growing day by day. Utilization of wastepaper for manufacture of different grades of paper requires pulping, screening, washing, flotation and bleaching.

Bleaching chemicals that contains chlorine such as chlorine water, chlorine dioxide and sodium hypochlorite have been used as bleaching agents. Though they are inexpensive and very effective in bleaching, the usage was restricted due to various reasons like 'AOX' formation, reductions in yield and colour reversion etc. Production of chlorinated derivatives during bleaching have led to reduction in their use. Traditionally Sodium Hydrosulphite and Hydrogen Peroxide have been used to bleach deinked ground wood pulps. For high brightness gains combination of hydrogen Peroxide and Sodium Hydrosulphite bleaching is most efficient. Brightness improvement in recycled deinked pulp depends upon(1)

1) Type of Wastepaper.

2) Ink removal efficiency of washing or floatation equipment.

3) Amount of efficiency of water clarification.

4) Bleaching methods.

The following factors are considered to select the bleaching process(2).

a) Reduction in bleaching costs.

b) Reduction of pollution load such as BOD, COD, Toxicity and AOX.

c) Reduction of Water consumption.

Rama Newsprint and Papers Ltd.
Vill. Barbodhan, Tal. Olpad,
Distt - SURAT - 395 005 (Gujarat)

d) Improvement of pulp quality in terms of strength at a reasonable drainage rate and good optical properties like brightness, Opacity and cleanliness.

e) Flexibility and easy control to ensure constant pulp quality.

HYDROGEN PEROXIDE AS BLEACHING AGENT

Hydrogen Peroxide is a very effective lignin preserving bleaching agent. Hydrogen Peroxide has the advantage of being compatible with the environment as it decomposes into water and oxygen. In alkaline conditions Hydrogen Peroxide ionises into 'Perhydroxyl' ions and Hydrogen.

$$H_2O_2 + OH^- \rightarrow OOH^- + H_2$$

Perhydroxyl ions are supposed to be active bleaching agents. The bleaching of recycled fibre with Hydrogen Peroxide needs the optimisation of both chemical and physical parameters to initiate and support the perhydroxyl ion formation and to prevent H_2O_2 decomposition. The reaction of Hydrogen Peroxide with lignin rich pulp leading to brightening effect are considered as due to nucleophilic addition of perhydroxyl anion to unsaturated aldehydes, conjugated double bonds and side chain carbonyls attached to the substituted benzene ring. Hydrogen Peroxide being a mild oxidising agent, the lignin skeleton remains largely unchanged while some individual chromophoric and auxochrome groups are attached (5). The Hydrogen Peroxide breaks bonds in the print network which can help detach print from fibres and also create smaller print particles which is removed by washing/floatation process(4).

Deinked pulps do not respond as well to bleaching as virgin pulp (4). For instance during Peroxide bleaching of mechanical pulps, 6-8 points increase can be expected from 1.0%, 12 to 15 points from 2.0% and 17 to 18 points from 3.0% Peroxide dose. However, about 20-25 points brightness gain was reported in some chemi mechanical pulps with 2.75% H_2O_2 dose(5).

Factors to be considered in recycled pulp bleaching are:

(i) Furnish plays a vital role in bleaching of recycled fibre. The type and quality of the recycled fibre should be selected depending upon the age and homogeneity of the furnish, especially ground wood grades which are more susceptible to yellowing from light. Even short periods of less than six months of aging can result in the loss of 1-2 brightness points. Heterogeneity of recycled fibre furnish, the bleaching costs will be high and it is difficult to achieve uniform desired brightness level with a single stage bleaching and hence double stage bleaching is advisable.

(ii) High residual ink and metal contamination critically affect the bleaching response. The metals and ink have a tendency to travel with the fibres and fines. In order to get a good response of bleaching the addition of chelants such as Ethylene Diamine Tetra acetic acid (EDTA), Diethylene Triamine Penta acetic acid (DTPA), Diethylene Triamine Penta monophosphonic acid (DTMPA) can be used to control the metals.

(iii) High absorption properties

The reduction of Resins and fatty acids begins in pulping stages and further reduced in bleaching with Hydrogen Peroxide resulting in high absorption properties when compared with the virgin fibre. Higher absorption properties are better for Newsprint and tissue papers (7).

(iv) Temperature

H_2O_2 is not efficient when used at moderate temperature for bleaching. Increase in temperature gives greater breakdown of Hydrogen Peroxide. Above 80°C most of this appears to be decomposition without a bleaching effect.

Keeping the Pulp temperature 65°C - 70°C during H_2O_2 bleaching prevents Hornification effect. Strength loss due to Hornification is prevented by alkaline medium employed during bleaching and keeping the temperature between 50-60°C. The Hornification due to degradation of fibre structure leads to reduced swelling capacity of recycled fibres (6).

(v) Sodium Silicate Dosage:

Increasing the silicate content improve the stability of Hydrogen Peroxide and

dispersion of ink particles. Sodium Silicate prevents ink from redepositing and agglomerates small ink particles to form larger ones (> 10 μ) so that they have a more suitable size for further removal (7).

(vi) Pulp Consistency

As per Mr. Randers (7) high consistency bleaching leads to higher brightness than with medium consistency treatment. Because of the constraints in laboratory the consistency was kept at 10% only. Higher the consistency shorter the time that is needed for the bleaching action keeping other conditions same.

(vii) Sodium Hydroxide Dosage

The consumption of peroxide increases continuously with caustic soda content, but the same cannot be said of the brightness. Caustic Soda dosage below the optimum results in inadequate activation of bleaching. However, when the alkalinity becomes excessive pulp yellowing takes precedence over brightness(8).

(viii) Role of Magnesium Sulphate

Magnesium Cation stabilise the Perhydroxy anion as per the following reaction forming magnesium perhydroxide which is more stable than perhydroxy ion (9)

$$Mg^{++} + 2HOO^{-} \rightarrow Mg(OOH)_2$$

(ix) Silicate free bleaching

Sodium silicate has certain disadvantages like scale formation on equipments. Usage of non-silicate based stabilizer to replace sodium silicate in Peroxide bleaching are giving encouraging results in lab scale. However successful plant scale results were not been reported.

(x) Decomposition of Peroxide

Recycled fibre is an excellent nutrient for bacteria to produce enzymes in Tropical condition. These enzymes lead catalytic decomposition of H_2O_2 releasing oxygen gas which may adversely affect Peroxide bleaching (5). The preventive steps like draining and cleaning the system, temperature shock, addition of hypochlorite, dosage of Paracetic acid (7) can be taken.

LAB EXPERIMENTS

In order to study the bleaching effect of Hydrogen Peroxide on recycled fibre the following bleaching experiments were conducted in lab scale to study the brightness development of Deinked pulps made from the furnish of (a) 100% old Newsprint (b) 100% Coated Magazines (c) 100% yellow pages (d) 100% Note Books and virgin pulps like BCTMP and Chemical pulp. All the recycled pulp were prepared by simulating Deinking Washing system and the pulp was bleached with the Hydrogen Peroxide. The parameters maintained are given in Table-1. No chelants have been used in these experiments as water quality was good. The bleached pulp was diluted to 1.0% and neutralised with H_2SO_4 upto pH 7. Brightness pads were prepared as per TAPPI without further washing. Brightness was measured on the top of the pad using 'Colour Touch' from Technidyne. All the chemicals addition levels are on 100% basis as a weight percentage on over dry pulp. Sodium Silicate is used on solution basis (Water glass 40°Be) with its addition level being expressed as a percentage on ovendry pulp of the product. Resluts are tabulated in Table-1 and the graphical representation is given in Fig-1 and 2.

RESULTS AND DISCUSSION

From the Table-1 and Fig -1 and 2, we can see:

1. Increasing dosage of H_2O_2 results in increase in fibres levels of both recycled fitness and virgin pulps. The level of increase in brightness is more for virgin pulps compared to recycled fibers.

2. The incremental gains in brightness decrease with increasing dosage of peroxide.

3. 0.5% H_2O_2 dose result in 3.7 to 4.2 points brightness gain in recycled fibre and 5.3 to 5.6 points brightness gain in virgin fibre.

4. Shifting from 0.5 to 1.0% dose, brightness gain was 2.0 to 3.2 points in recycled Fibre and 1.0 to 1.5 points in virgin Fibre. Further increase in dose level from 1.0 to 1.5% resulted in incremental gain of brightness to the extent of 1-2 points only in recycled

Table-1 BLEACHING CONDITIONS

Consistency, % = 10

Temperature, °C = 65

Retention Time, min. = 90

$MgSo_4$, % = 0.05

Na_2SiO_3, % = 1.25

PARAMETER	O.N.P.			MAGAZINE		NOTE BOOKS			YELLOW PAGES			B.C.TM.P.			EUCALYPTUS CHEMICAL PULP	
Initial Br., % ISO	47.10			59.10		70.20			44.30			63.20			75.20	
H_2O_2, %	0.50	1.00	1.50	0.50	1.00	0.50	1.00	1.50	0.50	1.00	1.50	0.50	1.00	1.50	0.50	1.00
NaOH, %	0.80	1.00	1.20	0.80	1.00	0.80	1.00	1.20	0.80	1.00	1.20	0.80	1.00	1.20	0.80	1.00
Res H_2O_2, %	0.06	0.08	0.12	0.02	0.04	0.03	0.04	0.05	0.01	0.02	0.02	0.04	0.06	0.08	0.02	0.06
Final Br., % ISO	50.80	53.20	54.80	62.90	66.10	74.40	76.50	78.40	56.00	58.60	60.80	68.50	69.90	71.00	80.70	81.80

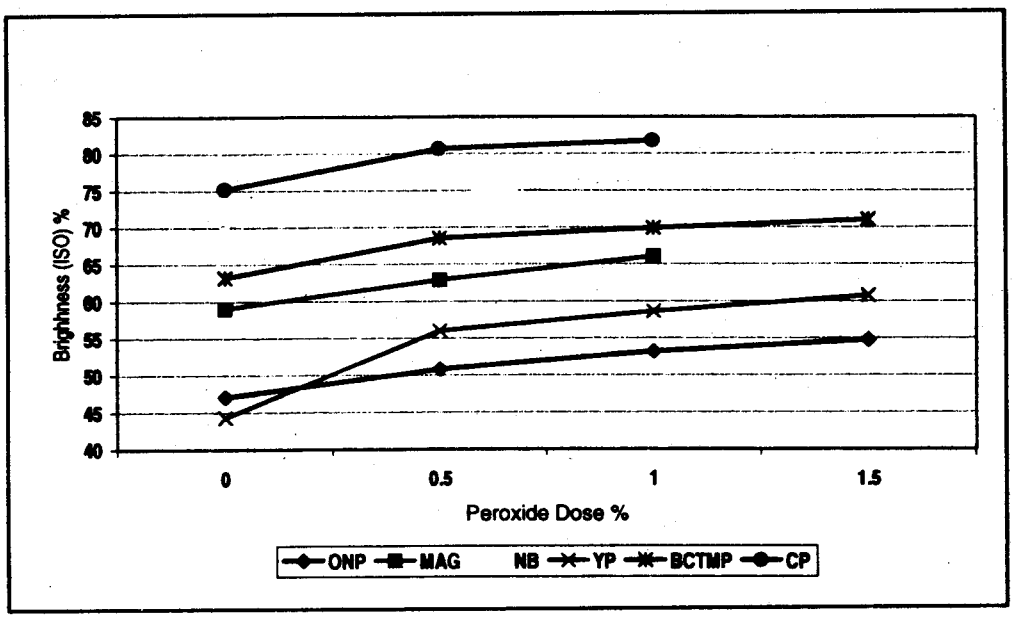

Fig. 1 Peroxide Bleaching of Various Furnish

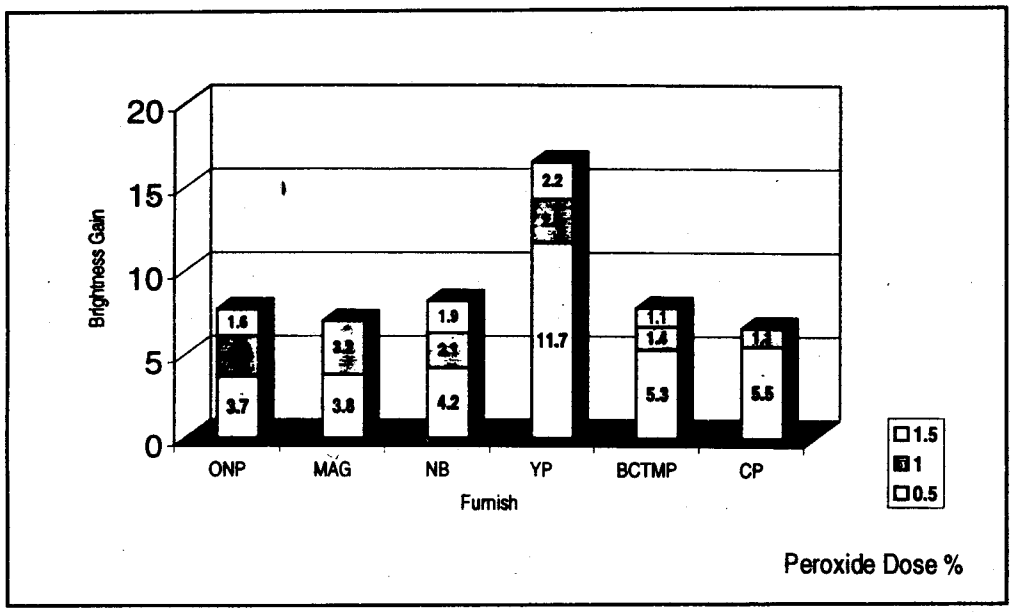

Fig. 2 Peroxide Dose Vs Brightness Gain

fibre pulp.

5. Th initial brightness of imported yellow pages from USA was 44.3%. The gain of 14 points increase in brightness was observed to be much higher compared to other pulps. The phenomena may be due to the recycled grade dyes and inks used in paper manufacturing and in printing press and also the kind of pulp used to produce the base paper. Further studies are required to establish the facts.

CONCLUSION

a) With 0.5% H_2O_2 dose the brightness gain varied

from 3-6 points depending upon the furnish and initial brightness.

b) With 1.0% H_2O_2 dose 6-7 points gain in brightness is achieveable whatever may be initial brightness and furnish.

c) Increase in the H_2O_2 dose level further gives only marginal improvement in brightness.

d) Higher residual peroxide was observed in ONP after bleaching compared to other raw materials.

e) The ONP and 100% yellow pages can be utilised for manufacturing of newsprint.

f) Combination of Note Books and Magazines can be used for manufacturing of quality papers.

ACKNOWLEDGEMENT

The Authors are thankful to the RNPL Management for giving encouragement and permission to publish this paper.

REFERENCES

1) Michael Dodson and Lowelldean, Recycling Process, Pulp & Paper, Sept. 1990.

2) Christine Chirat and Dominique Lachenal, "Pulp Producers race to keep up with technology", PPI, P-29, Oct. 97.

3) G. Galland, E. Bernard and Y. Verac, "Achieving a Deinked Pulp with High Brightness". Paper Technology, P-28, December, 89.

4) B.R. Read, Tappi Pulping Conference 1991, Book-2, P 851-856.

5) K. Yesuadian, J.V.R. Reddy, J.D. Fernades etal, "Hydrogen Peroxide Bleaching of Eucalyptus chemimechanical Pulp," IPPTA Vol-5(3), Sept. 93.

6) Ferguson, "Effects of Recycling on Strength Properties," Paper Technology, No-10, P-33.

7) A. Renders & J.K. Huston, "Recycled Fibre bleaching," Technology of Paper Recycling, P-162, P-306.

8) J. de Ceuster etal, "H_2O_2 Bleaching in Waste Paper Recycling," Paper Technology and Industry, April 77.

9) V.A. Shenai, "Stabilisers for Hydrogen Peroxide," Chemical Weekly, Oct.' 97, P-137.