# Hydrogen Peroxide: An Ideal Chemical For Brightening of Recycled Fibres

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## INTRODUCTION

The demand for all types of paper is increasing day by day due to civilisation and also due to increase in level of literacy. There is tremendous gap between supply and demand of newsprint, as well as writing printing paper. Due to non-availability of conventional raw materials, paper industry in India has been forced to search for suitable source of fibres to meet this increasing demand of paper. It was estimated (1) that by 2000 AD the installed capacity of Indian paper industry would be 45 lakh tonnes and production would be around 32 lakh tonnes (75% capacity utilisation). Out of 32 lakh tonnes, 15.36 lakh tonnes paper would be produced by recycling of paper for which approximately 20 lakh tonnes of waste paper would be required as the raw material. It was estimated that 4.25 lakh tonnes of deinked paper would be produced by 2000 AD. However, looking at the pace in which the paper industry is moving, it appears that the production of deinked paper would even exceed 5.0 lakh tonnes by 2000 AD. The world-wide scenario of recycled paper was also discussed by Higgins(2).

The published literature(3-9) have already dealt with problem of collection, utilisation of waste paper in Indian context. The literature have also explained about various methods as well as developments (10-14) in deinking process.

Although some paper mills in India are planning to manufacture writing printing paper as well as tissues by using waste paper, by and large, most of the paper mills are already in manufacture or in planning stage to manufacture newsprint to supply the market demand. The state of art technology has been adopted by some large mills from their overseas counterparts.

One of the major target areas for increased use of recycled fibres is newsprint. Most of this pulp in this category is already bleached by hydrogen peroxide. The waste paper or newsprint which is being slushed is either in coated or in printed form. Similarly during the slushing, for many reasons various raw material mix is being used. Thus, the chemical nature of recycled fibres becomes increasingly more complex. The paper made out of recycled fibres has distinct ink specks on the sheets. The consumers of paper do not want paper with recycled look. The market demands paper of high quality with regard to brightness and cleanliness. A response to this suitable physicochemical method are being adopted to produce high quality papers. Equipment manufacturers/consultants are also recommending Flotation Deinking, Washing Deinking, combination of Flotation Deinking and Washing Deinking, Post Deinking Bleaching and even Hot Dispersion to produce brighter and cleaner secondary pulp.

During the text of this paper emphasis has been given to explain the role of hydrogen peroxide during recycling of waste paper.

## ROLE OF HYDROGEN PEROXIDE

Mechanical forces are being applied during slushing and also during other operations leading to weaken the fibres. Hydrogen peroxide being safe as well as eco-friendly bleaching agent as compared to other bleaching chemicals available, plays a vital role at various stages during the processing of the secondary fibres(15,16).

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### *Pulper*

Generally caustic soda and sodium silicates are used at pulper stage to saponify the ink resins and to disperse it. Alkaline environment swell the fibres. However, this alkaline condition generates chromophores especially due to its action on wood containing fibres. This is called alkali darkening. This can be very well controlled by usage of hydrogen peroxide at pulper. In alkaline conditions hydrogen peroxide behaves as given in the equation below:

$$H_2O_2 + NaOH = HOO^- + H^+ + Na^+ + OH^-$$

The perhydroxyl ion generated in alkaline condition is an effective bleaching ion. It is, therefore, necessary to generate sufficient amount of perhydroxyl ions. There is, however, always hindrance from ink, loading material, metallic ions, bacteria etc. present on the paper. These materials lead to other competing reactions and lower the bleaching efficiency of hydrogen peroxide. In order to improve the efficiency of hydrogen peroxide, it is necessary to have following conditions:

- pH should be always above 10.0 preferably between 10.0-10.5
- Temperature should be always above 50°C.
- Consistency should be as high as possible.
- Reaction time should be sufficient.
- Competing reactions should be minimum.
- Usage of hydrogen peroxide should be sufficiently enough.

Every furnish behaves in a different manner. Hence it is necessary to study the furnish carefully in the laboratory before it is subjected to plant. It has been observed that Indian office waste and exercise note books have initial low brightness and hence the pulp made of these raw materials can be bleached at pulper stages by usage of hydrogen peroxide.

### *Hot Dispersion*

In developed countries, hot dispersion is now becoming a standard equipment in deinking line. Many Indian waste paper based paper mills are already in the process of installing hot dispersion system. In the hot dispersion unit, the residual ink on deinked pulp is dispersed into micron size to give uniform appearance for paper made out of pulp. However, due to this uniform distribution of ink and high temperature the brightness of pulp drops. This brightness loss can be avoided by using hot dispersion system for bleaching by usage of hydrogen peroxide. The advantage of high temperature and of high consistency is taken for peroxide bleaching(17).

### *Tower Bleaching*

Tower bleaching of chemical as well as mechanical pulp by hydrogen peroxide is well known. The similar way deinked secondary fibres can also be bleached by usage of hydrogen peroxide.

## EXPERIMENTAL

A large number of experimentation was carried out at NPL Research Centre on various raw material mix. Similarly, number of plant trials were also conducted in Indian paper mills based on recycled fibres. The data generated has been presented below in the form of case studies.

### CASE STUDY-1

**Raw Material**

Office Waste : 50%
Ex. note book : 50%
$H_2O_2$ : At pulper

| PARAMETERS | Blank | 1 | 2 | 3 |
|---|---|---|---|---|
| NaOH % on OD pulp | 1.4 | 1.1 | 1.2 | 1.3 |
| Na Silicate (40°Be)% | 1.6 | 1.6 | 1.6 | 1.6 |
| $CaCl_2$% | 0.04 | 0.04 | 0.04 | 0.04 |
| Surfactant % | 0.1 | 0.1 | 0.1 | 0.1 |
| $H_2O_2$(100%) % | - | 0.25 | 0.5 | 1.0 |
| Consistency % | 5 | 5 | 5 | 5 |
| Temperature °C | 50 | 50 | 50 | 50 |
| Retention Time (min.) | 60 | 60 | 60 | 60 |
| Brightness °ISO | 56.2 | 60.8 | 63.2 | 64.2 |

# All chemicals on O.D. PULP.

This is a classic case of development of brightness at pulper stage by usage of $H_2O_2$ without any flotation or washsing deinking. The furnish is of chemical origin and development of brightness here

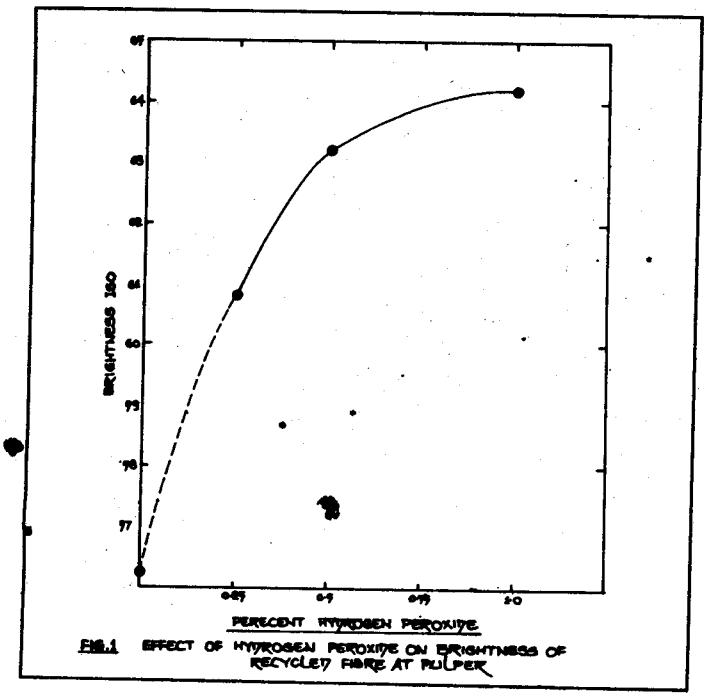

FIG.1 EFFECT OF HYDROGEN PEROXIDE ON BRIGHTNESS OF RECYCLED FIBRE AT PULPER

is shown graphically in FIG.1

**CASE STUDY-2**

**Raw Material**

| | | |
|---|---|---|
| Office Waste | : | 30% |
| Ex.note book | : | 30% |
| White cuttings | : | 40% |
| $H_2O_2$ | : | At Chest |

| PARAMETERS | Blank | 1 | 2 |
|---|---|---|---|
| $H_2O_2$(100%) % | - | 0.25 | 0.5 |
| NaOH % | 0.8 | 0.8 | 0.8 |
| Na-Silicate (38° Be) % | 2.0 | 2.0 | 2.0 |
| Temperature °C | 60 | 60 | 60 |
| Consistency % | 5 | 5 | 5 |
| Retention Time (min.) | 60 | 60 | 60 |
| Brightness °ISO | 51.6 | 61.2 | 63.2 |

# All chemicals on O.D. PULP.

The mill is in manufacture of duplex board. The pulp under study was for underlayer of duplex board. This pulp is again of chemical origin. No chemicals were used at pulper stage. The pulp was bleached separately by usage of hydrogen peroxide in the laboratory.

**CASE STUDY-3**

**Raw Material**

Magazine cuttings 40%

| | | |
|---|---|---|
| White Record | : | 30 % |
| Office record | : | 20 % |
| Ex.note book | : | 10 % |
| $H_2O_2$ | : | At Pulper |

| I Pulper | Blank | With $H_2O_2$ |
|---|---|---|
| Caustic % | 2.0 | 1.4 |
| Na-Silicate(38°Be) % | 4.0 | 4.0 |
| Acid Slurry % | 0.5 | 0.5 |
| Surfactant % | 0.14 | 0.14 |
| $H_2O_2$(100%) % | - | 0.8 |
| Consistency % | 5.0 | 5.0 |
| Temperature °C | 50 | 50 |
| Retention Time (min) | 30 | 30 |
| # All chemicals on O.D. PULP. | | |
| II DE-INKING PLANT Inlet | | |
| Brightness %PV | 50.5 | 55.0 |
| outlet Brightness %PV | 52.5 | 58.5 |
| III FINAL PULP TO P M/C | | |
| Brightness %PV | 52.5 | 60.0 |
| IV PAPER | | |
| Brightness %PV | 49-50 | 58-60 |
| BREAKING LENGTH (Meters) | | |
| Machine Direction(MD) | 1700 | 1600-1900 |
| Cross Direction (CD) | 960 | 1100-1500 |

This is a classic example of the plant trials conducted at one of the newsprint mills in India. By the usage of hydrogen peroxide at pulper, not only

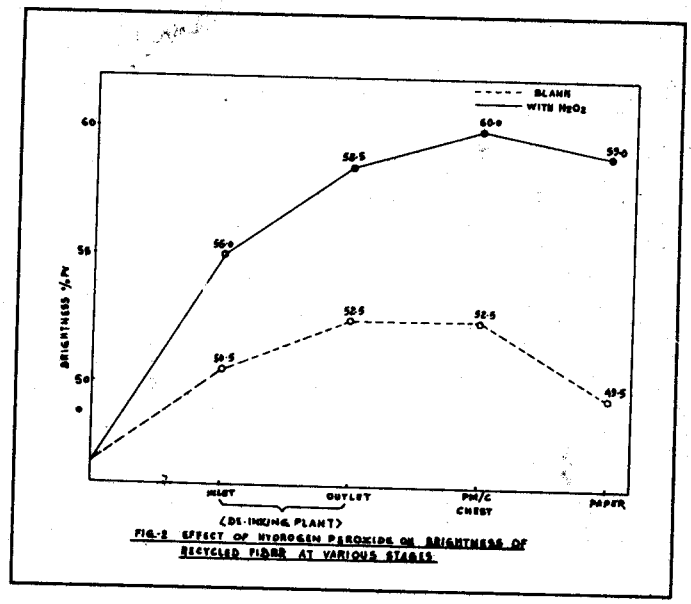

FIG-2 EFFECT OF HYDROGEN PEROXIDE ON BRIGHTNESS OF RECYCLED FIBRE AT VARIOUS STAGES

the brightness of pulp/paper increased but even breaking length in Cross Direction increased dramatically. This has resulted in improved runnability of the paper machine. The results are shown graphically in FIG-2.

## CASE STUDY-4

**Raw Material**

Old Newsprint - 60%
Old Magazines - 10%
Books/Share form,office records- 30%

| PULPER | |
|---|---|
| Sodium Silicate (38°BE) % | 2.0 |
| Soap (fatty acid) % | 0.15 |
| De-inking chemical % | 0.3 |
| Caustic% | 0.5 |
| Ca-Chloride% | 0.25 |
| $H_2O_2$ (100%) % | 1.0 |
| Consistency% | 5.0 |
| Temperature °C | 50.0 |
| Retention time (min) | 45.0 |
| BRIGHTNESS °ISO | |
| With Chemicals(except $H_2O_2$) | 39.3 |
| With $H_2O_2$ treatment | 42.8 |

# All chemicals on O.D. PULP

| FLOTATION | |
|---|---|
| De-inking chemical % | 0.3 |
| Consistency % | 1.0 |
| BRIGHTNESS °ISO | |
| Flotation Initial | 45.5 |
| Flotation After 4 min. | 47.1 |
| Flotation After 8 min. | 47.5 |
| Flotation-After 8 min. Acidified to pH5.0 | 48.3 |

The development of brightness at various stages has been shown in FIG-3.

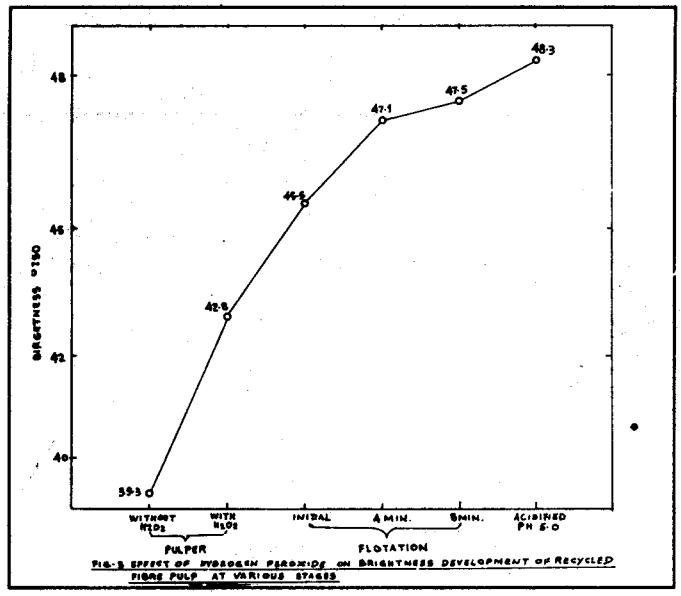

FIG-3 EFFECT OF HYDROGEN PEROXIDE ON BRIGHTNESS DEVELOPMENT OF RECYCLED FIBRE PULP AT VARIOUS STAGES

## CASE STUDY-5

**Raw Material:** 100% old Newsprint (ONP)

| PULPER | |
|---|---|
| Sodium Silicate (38°Be) % | 2.0 |
| Soap (fatty acid ) % | 0.15 |
| De-inking chemical % | 0.3 |
| Caustic % | 0.5 |
| Ca-Chloride % | 0.1 |
| $H_2O_2$ (100%) % | 1.0 |
| Consistency % | 4.5 |
| Temperature °C | 40 |
| Retention time (min) | 10.0 |
| BRIGHTNESS °ISO | |
| With chemicals(except $H_2O_2$) °ISO | 36.6 |
| With $H_2O_2$ treatment °ISO | 39.7 |

| FLOTATION | |
|---|---|
| De-inking chemical % | 0.3 |
| Consistency % | 1.0 |
| Flotation After 8 min. °ISO | 43.4 |

| HOT DISPERSION | |
|---|---|
| Sodium Silicate(38°Be) % | 2.0 |
| Caustic % | 0.5 |
| $H_2O_2$ (100%)% | 0.75 |
| Consistency % | 30 |
| Temperature °C | 75 |
| Retention time (min) | 3.0 |
| BRIGHTNESS °ISO | |
| After dispersion | 45.8 |
| After dispersion diluted to 5% consistency and acidified to pH 5.0 | 46.8 |

# All chemicals on O.D. PULP

The laboratory study was conducted by simulating disperser conditions in the laboratory by using high speed kitchen mixer. The pulp was subjected for bleaching at temperature of 75°C for 3 minutes only. The total brightness gain has been shown graphically in FIG 4.

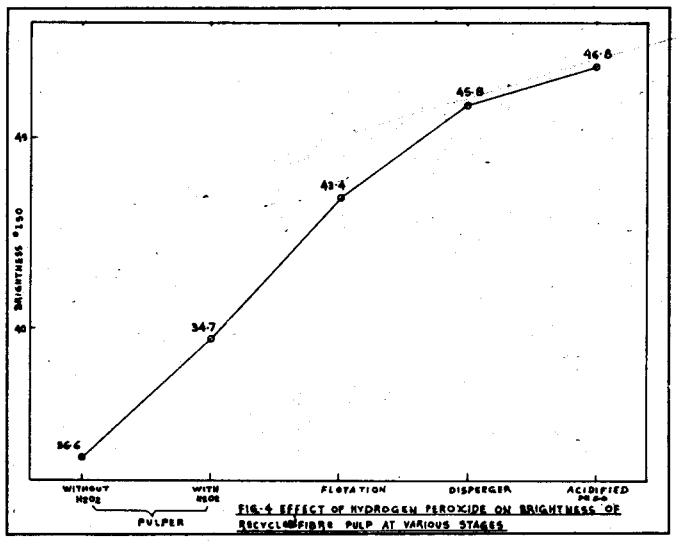

FIG-4 EFFECT OF HYDROGEN PEROXIDE ON BRIGHTNESS OF RECYCLED FIBRE PULP AT VARIOUS STAGES

## CONCLUSIONS

From the case studies presented on the basis on laboratory experimental work as well as actual plant trials, it can be concluded that:-

4.1 Hydrogen peroxide can be effectively used for brightening of recycled fibres at pulper as well as post deinking bleaching stage either in chest or in high density tower.

4.2 Besides brightening the fibres at pulper and bleaching stage, hydrogen peroxide plays very important role at hot dispersion stage. A hot dispersion system not only can be used for dispersing the ink uniformly but it can also be used to bleach the pulp by usage of hydrogen peroxide and to compensate the brightness drop.

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