

High Permanence Paper from Jute

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ABSTRACT

Consumption of paper is an indicator of the development of the country. India being a high growth rate country requirement of paper is increasing day by day necessitating a large amount of cellulosic raw materials. To meet this challenge several alternative ligno-cellulosic raw materials can be adopted in addition to the traditional raw materials like wood and bamboo. Jute deserves a place in the list of alternative raw material for paper manufacture specially in the handmade sector. Handmade papers have high demand in value added products like greetings cards, archival documents, certificate papers, chart papers and packaging papers. More over it serves the social objective of creating gainful employment to the rural poor, since 70 % of our population live in the villages and nearly half of them are below the poverty level. Alkaline sulphite pulp of jute was bleached by four different multi-stage pulping methods and finally the bleached pulps were treated with anti-ageing chemicals and standard hand sheets were made. The bleached paper samples were subjected to accelerated ageing tests for 1, 3 and 5 days following the method adopted by Preservation Research and Testing Division, Library of Congress, USA. All the paper samples were evaluated for their optical and physical properties before and after ageing. The study showed that among the treated samples the borohydride-hydrogen peroxide bleached jute paper was resistant up to 3 days of exposure to accelerated ageing, whereas, the control sample was resistant up to 1 day of exposure. The study is based upon the values of the whiteness index, 457 nm brightness, yellowness index, tensile index, burst index and fold number. The results are corroborated by the high pH value of the treated paper samples compared to the untreated samples, indicating the absence of aliphatic acids as a result of accelerated ageing. Thus high permanence paper can be obtained from the alkaline sulphite jute pulp bleached by borohydride-hydrogen peroxide process followed by anti-ageing chemical treatment.

Key Words: Jute Fibre, alkaline sulphite pulping, accelerated ageing, bleaching of jute pulp

INTRODUCTION

India has about 2795 handmade paper units (1) which are mainly based on cotton rags, hosiery cuttings, tailor cuttings and small quantities of waste paper. The increasing demand of handmade paper has left a big gap between the projected demand of 28000 tons in 2010 and the present production of 15000 tons (2). This gap can be reduced by introducing alternative ligno-cellulosic raw material like jute.

Jute is an annual plant which grows to the tune of about 1.5 million tons (3,8). Jute can be used as an alternative raw material if we can produce permanent paper or archival paper from jute. To achieve this we have to assess the age or self life of jute based paper. The present study was carried out to study the effect of accelerated ageing by the method developed by Preservation Research & Testing Division, Library of Congress, Washington DC, USA (4).

Jute based paper being ligno-cellulosic in a nature is susceptible to ageing which is manifested by change in color or the strength properties of the

bleached and dyed paper. Although study on the effect of accelerated ageing on treated paper from cold soda jute pulp over different periods of interval has been reported (7) no work on the effect of accelerated ageing on paper from alkaline sulphite pulp of jute has yet been reported.

Jute was pulped by alkaline sulphite pulping process, the pulp was bleached by conventional hydrogen peroxide process and four other multistage bleaching processes I to IV. The bleached and the treated paper samples were subjected to accelerated ageing for different periods of interval i.e., 1, 3, and 5 days. The after-aged samples along with the before-aged samples were evaluated for their optical properties, physical properties and pH values.

MATERIALS AND METHODS

Raw material

Jute fibre was cut into 2-4 cm pieces and used for alkaline sulphite pulp.

Alkaline sulphite pulp of jute (ASP)

Jute pulp was prepared by alkaline sulphite pulping process in a rotary digester at 13% Na₂SO₃ and 3% NaOH, using 1:10 liquor ratio, at 160^o, for 1 hour, yield was 75-78%.

Kappa number

The Kappa number of the bleached pulp was determined by the Tappi Test Method - Tappi 236 cm-85 (5).

Bleaching of jute pulp (HBU)

A portion of the unbleached alkaline sulphite pulp was bleached in a covered vessel using H₂O₂ (20 ml/l) at 1:20 material to liquor ratio, trisodium phosphate (5 g/l), sodium hydroxide (1g/l), sodium silicate ((10g/l) for 1.5 h at 80^o C. The pH was maintained at around 10. The bleached pulp was washed in normal water and neutralized with sulphur dioxide water for 15 min.

Table -I

Paper samples	Control HBU	I	II	III	IV
Kappa no.	24.6	22.7	25.3	25.05	24.3
Lignin %	3.70	3.40	3.79	3.75	3.64

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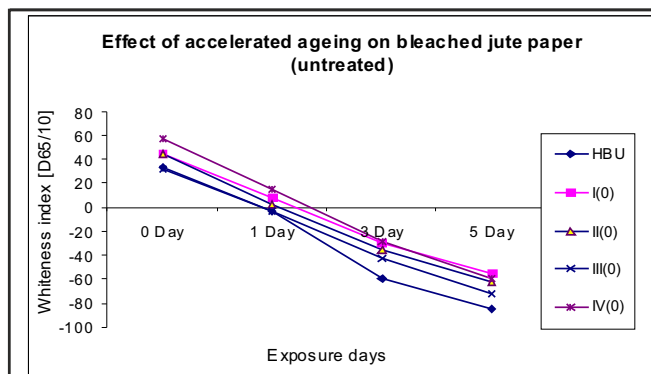


Fig- 1 Effect of accelerated ageing on W.I. of Untreated BJP

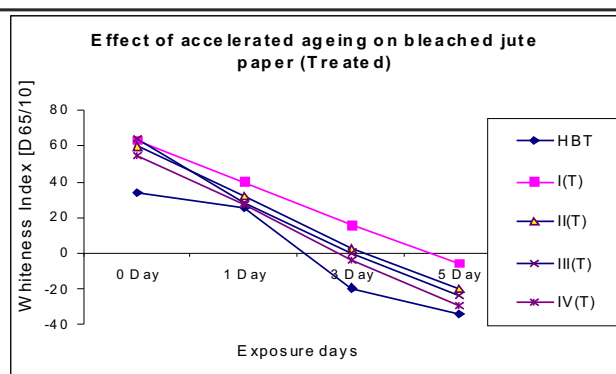


Fig- 2 Effect of accelerated ageing on W.I. of Treated BJP

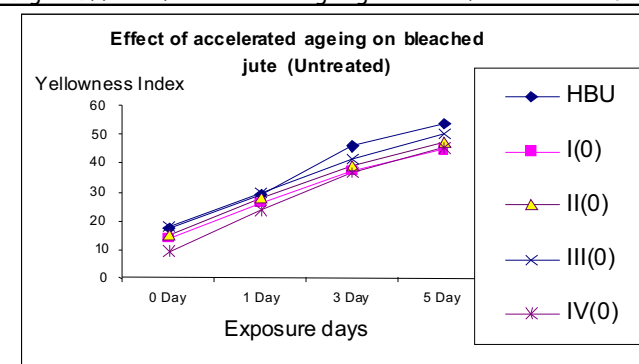


Fig- 3 Effect of accelerated ageing on Y.I. of Untreated BJP

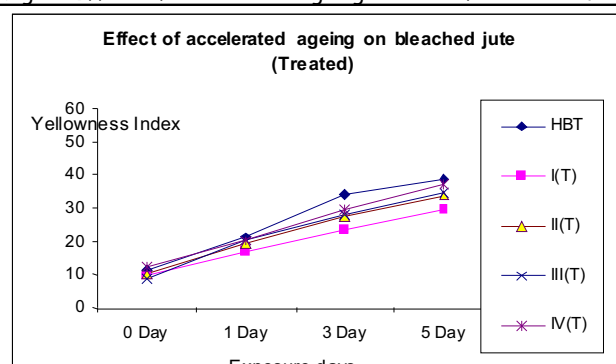


Fig- 4 Effect of accelerated ageing on Y.I. of Treated BJP

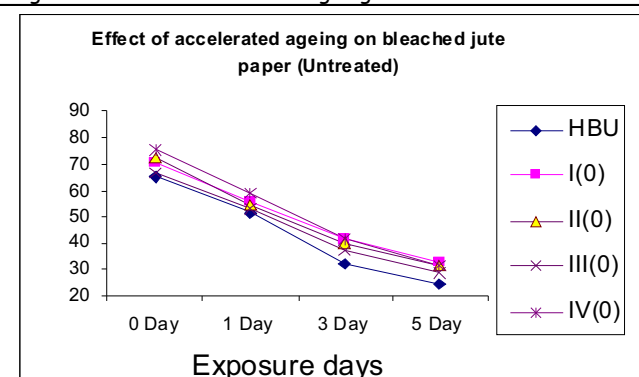


Fig- 5 Effect of accelerated ageing on 457nm Brightness of Untreated BJP

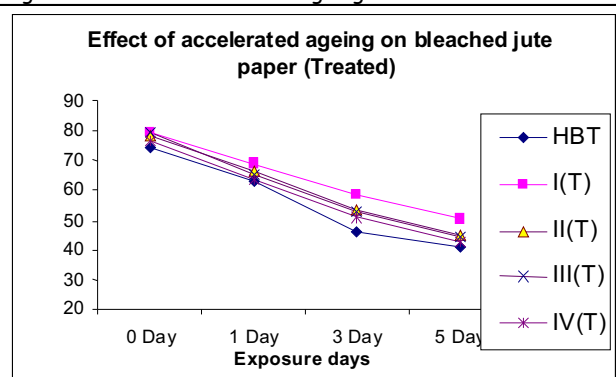


Fig- 6 Effect of accelerated ageing on 457nm Brightness of Treated BJP

HBU= Hydrogen peroxide bleached paper (untreated)
I(O), II(O), III(O), IV(O) = Untreated bleached Jute Paper
BJP=Bleached Jute Paper

HBT= Hydrogen peroxide bleached paper (treated)
I(T), II(T), III(T), IV(T)= Treated bleached Jute Paper
BJP=Bleached Jute Paper

I = Borohydride- Peroxide (B-P), II = Hypochlorite-Extraction-Peroxide- Hydrosulphite (H-E-P-HS)
III = Peroxide-Hydrosulphite (P-HS), IV = Borohydride- Peroxide- Hydrosulphite (B-P-HS)

and was given a final wash for further preparation of standard hand sheets.

Other portions of the ASP pulps were bleached by four different pulping processes namely :

- I = Borohydride- Peroxide (B-P)
- II = Hypochlorite-Extraction- Peroxide- Hydrosulphite (H-E-P-HS)
- III = Peroxide-Hydrosulphite (P-HS)

IV = Borohydride- Peroxide- Hydrosulphite (B-P-HS)

(I) Borohydride- Peroxide (B-P) Bleaching

The alkaline sulphite pulp was treated with 1 % (on weight of pulp) NaBH_4 , Na_2SiO_3 (10 g/L), at 1:20 material to liquor ratio, time of treatment 1 hr, Temperature 60° . The reductive

bleaching treatment was followed by H_2O_2 oxidative bleaching in the same bath, using (10ml/L) H_2O_2 , Trisodium phosphate (5g/L), NaOH (1 g/L) at 80° for 1.5 hr. The pulp was thoroughly washed and treated with SO_2 water for 15 min. followed by washing with water.

(II) Hypochlorite-Extraction- Peroxide- Hydrosulphite (H-E-P-HS)

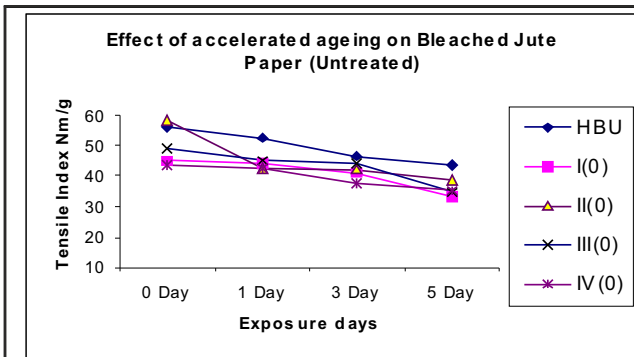


Fig- 7 Effect of accelerated ageing on T.I. of Untreated BJP

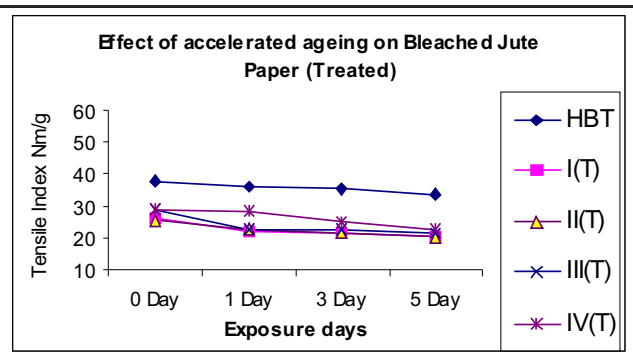


Fig- 8 Effect of accelerated ageing on T.I. of Treated BJP

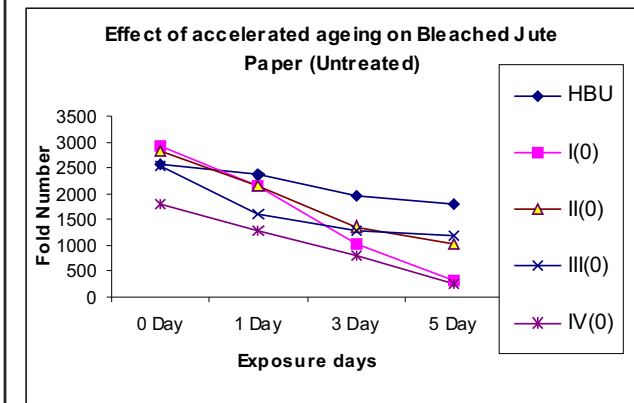


Fig- 9 Effect of accelerated ageing on F. No. of Untreated BJP

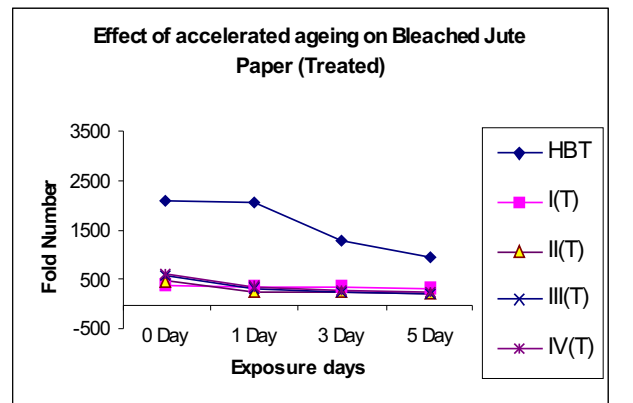


Fig- 10 Effect of accelerated ageing on F.No. of Treated BJP

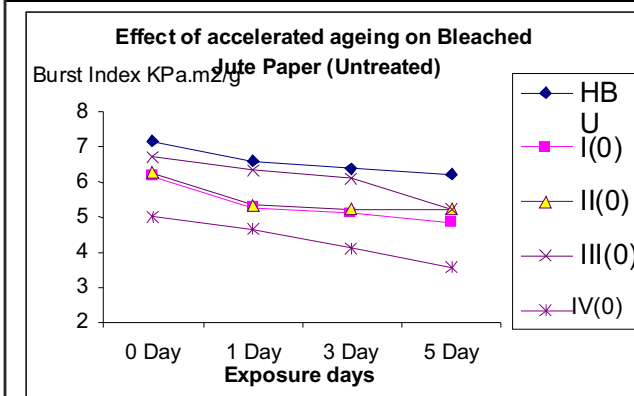


Fig- 11 Effect of accelerated ageing on B.I. of Untreated BJP

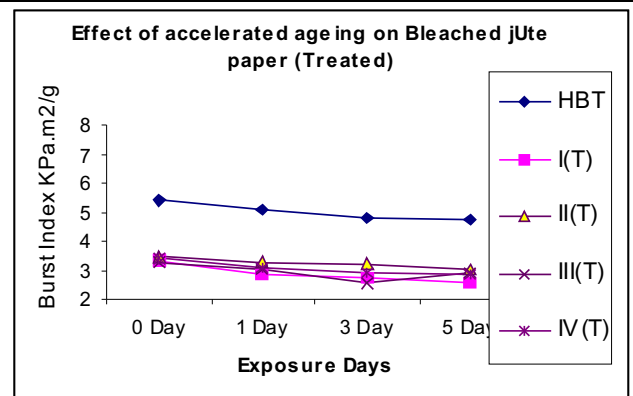


Fig- 12 Effect of accelerated ageing on B.I. of Treated BJP

HBU= Hydrogen peroxide bleached paper (untreated)
 I(O), II(O), III(O), IV(O) = Untreated bleached Jute Paper
 BJP=Bleached Jute Paper

HBT= Hydrogen peroxide bleached paper (treated)
 I(T), II(T), III(T), IV(T)= Treated bleached Jute Paper
 BJP=Bleached Jute Paper

I = Borohydride- Peroxide (B-P), II = Hypochlorite-Extraction-Peroxide- Hydrosulphite (H-E-P-HS)
 III = Peroxide-Hydrosulphite (P-HS), IV = Borohydride- Peroxide- Hydrosulphite (B-P-HS)

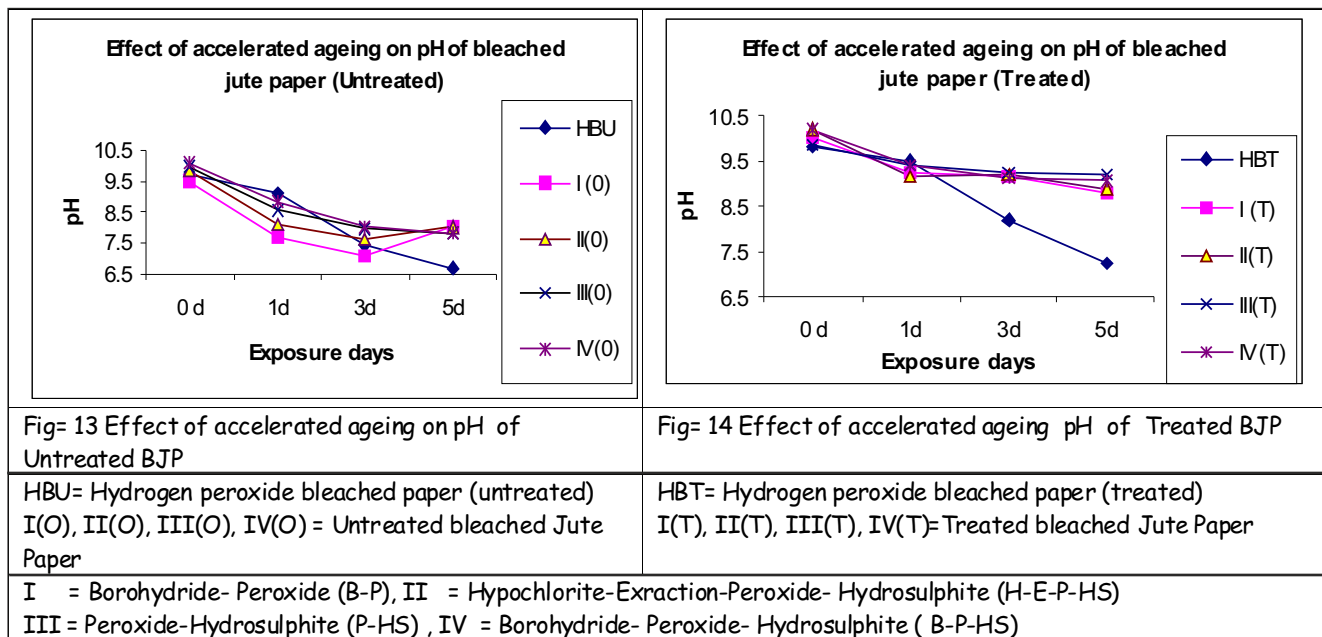
HS) bleaching

The pulp (ASP) was treated with 40ml/L NaOCl solution (4 % solution), (3 g/L) Na_2CO_3 was added to maintain the pH at 11.5, at 1:20 material to liquor ratio at a temperature of 60° for 1 hr, the bleached pulp was thoroughly washed and then extracted with NaOH (6 %) (on weight of pulp) at 1: 20 at a temperature 60° for 1 hr and then thoroughly washed and bleached with

(10 ml /L) H_2O_2 , EDTA (0.1 g/L), at 1: 20 material to liquor ratio, Na_2SiO_3 (5 g/L), Trisodium phosphate (5 g/L), NaOH (1 g/L) at 80° for 1.5 hr at pH 10.5. The pulp was washed thoroughly, and treated with SO_2 water for 15 min. followed by treatment with (1 % on weight of pulp) sodium dithionite at 1: 20 material to liquor ratio at a temperature of 70°, for 1 hr at pH 5 followed by washing.

(III) Peroxide-Hydrosulphite (P-HS) bleaching

The pulp (ASP) was bleached with (10 ml /L) H_2O_2 , at 1: 20 material to liquor ratio using Na_2SiO_3 (5 g/L), Trisodium phosphate (5 g/L), NaOH (1 g/L) at 80° for 1.5 hr at pH 10.5. The pulp was washed thoroughly, and treated with SO_2 water for 15 min. followed by treatment with EDTA (0.1 % on weight of pulp) and (1 % on weight of pulp)



sodium dithionate at 1: 20 material to liquor ratio at a temperature of 70^o, for 1 hr at pH 5 followed by washing.

(IV) Borohydride- Peroxide- Hydrosulphite (B-P-HS) bleaching

The alkaline sulphite pulp was treated with 1 % (on weight of pulp) NaBH₄, Na₂SiO₃ (10 g/L), at 1:20 material to liquor ratio, time of treatment 1 hr, Temperature 60^o. The reductive bleaching treatment was followed by H₂O₂ oxidative bleaching in the same bath, using (10ml/L) H₂O₂, Trisodium phosphate (5g/L), NaOH (1 g/L) at 80^o for 1.5 hr. The pulp was thoroughly washed and treated with SO₂ water for 15 min. followed by washing with water and then treatment with EDTA (0.1 % on weight of pulp) and (1 % on weight of pulp) sodium dithionate at 1: 20 material to liquor ratio at a temperature of 70^o, for 1 hr at pH 5 followed by washing.

Each of the pulp was treated with 20-25 % (on weight of the pulp) precipitated Ca CO₃ and standard hand sheets were made from both the untreated and treated pulp for further processing and evaluation of optical and strength properties.

Handmade paper and standard hand sheets

Standard hand sheets of about 60 GMS were made from all five bleached pulps i.e., HBU, I, II, III, IV and the five chemically (precipitated Ca CO₃) treated pulps.

Accelerated Ageing

All the paper samples i.e., five bleached paper samples HBU, I, II, III, IV and the five chemically (precipitated Ca CO₃) treated paper samples were sealed in air tight containers and subjected to accelerated ageing in an oven at 100^o C following the method adopted by at Preservation Research & Testing Division, Library of Congress, Washington DC, USA(4).

Evaluation of Physical Properties

Tensile Index was determined by Tappi Test Method - T 404 om-87 (5), Bursting Index was determined by Tappi Test Method - T 403 om-85 and Folding endurance of paper (Schopper type) was determined by Tappi Test Method - T 423 0m-89. The instruments used were Tensile Strength Tester Veb Thuringer Industriewerk, Raunstein (Germany), Double Fold Tester, Veb Werkstoffpriuma Schinen, Leiplig (Germany) and Bursting Strength Tester by Ubique Enterprises, Pune.

Evaluation of Optical Properties

Optical properties of the paper samples before and after subjecting them to accelerated ageing were evaluated for Whiteness Index E 313(D65/10) and Post color number in HunterLab Lab Scan XE Brightness tester.

Post color Number = 100x (K/S_{After Ageing} - K/S_{Before Ageing})
K= Co-efficient of absorption,
S= Co-efficient of scattering

pH Measurement

Paper sample (1g sample) was cut in to 2-3 mm size and soaked in 70 ml of distilled water for 1 hour, the pH was measured in Eutech CyberScan PCD 6500 apparatus (6).

RESULTS AND DISCUSSION

Four multistage bleached jute pulps along with the control bleached jute pulp were treated with anti-ageing chemicals and converted into standard hand sheets. The treated and untreated samples were subjected to accelerated ageing for 1, 3 and 5 days. The samples were evaluated for their optical properties i.e., Whiteness index, 457 nm Brightness and Yellowness Index and the strength properties namely, Tensile Index, Burst Index, Fold number and pH. Detailed analysis of the Figures 1-6 for the strength properties and Figures 7-12 representing the optical properties and the Figures 13-14 the pH of the samples show that among the treated samples the sample No. I (T) i.e. the Borohydride- hydrogen peroxide bleached jute paper was resistant up to 3 days of exposure. This is based on the highest value of the Whiteness index, 457 nm brightness and the least value of the Yellowness Index or the color reversion. The strength properties i.e., the Tensile Index, Burst Index and the Fold No. are also within acceptable limit i.e., strength loss is not more than 20% after accelerated ageing of 3 days duration. The fold number of the sample I(T) is also the highest among the four bleached samples studied.

The corresponding untreated sample I(0) is resistant upto 1 day of exposure. This is based on the value of the Whiteness index, 457 nm brightness and value of the Yellowness Index which is lowest. The strength properties i.e., the Tensile Index, Burst Index and the Fold No. are also under acceptable limit i.e., strength loss is not more than 20% after accelerated ageing of 1 day duration. The fold number of the sample I(0) is also the highest among the four bleached samples studied.

The results are corroborated by the high pH value of the treated samples as compared to the untreated samples, indicating absence of free aliphatic acids as a result of accelerated ageing. The degradation or cleavage of the cellulose chain is thus prevented. The treated samples thus show delayed ageing or increased permanence of the jute pulp bleached by the borohydride-hydrogen peroxide method.

From the detailed analysis of the Figures 1-6 for the strength properties, Figures 7-12 representing the optical properties and the Figures 13-14 representing the pH values the conclusion can be drawn as follows:

CONCLUSION

- That among the treated sample the borohydride- hydrogen peroxide bleached jute paper was resistant up to 3 days of exposure
- The corresponding untreated sample is resistant up to 1 day of exposure.
- The results are corroborated by the high pH value of the treated samples as compared to the untreated samples, indicating absence of free aliphatic acids in the treated samples as a result of accelerated ageing.
- The treated samples thus show delayed ageing or increased permanence for the jute pulp bleached by the borohydride-hydrogen peroxide method.

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