

Effect Of Accelerated Ageing On Cationic Starch Treated Lime Pulp Of Jute

Roy A.K, Chattopadhyay S.N and Khan A.

ABSTRACT

Consumption of paper is an indicator of the development of the country. India being a high growth rate country the 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 great 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. Cold lime pulp of jute was bleached by the multi-stage bleaching method and finally the bleached pulps were treated with anti-ageing chemicals along with cationic starch and standard hand sheets were made. The bleached paper samples were subjected to accelerated ageing tests for 1 to 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 the borohydride-hydrogen peroxide bleached jute papers treated with precipitated calcium carbonate along with cationic starch were highly resistant, whereas, the bleached samples treated with only cationic starch were least resistant to accelerated ageing. The study is based upon the values of the whiteness index, 457 nm brightness, yellowness 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 cold lime jute pulp bleached by borohydride-hydrogen peroxide process followed by anti-ageing chemical treatment.

Key Words: Jute Fibre, cold lime pulping, accelerated ageing, multistage 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 (3,11). 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 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 (7-10), but no work on the "effect of accelerated ageing on cationic starch treated lime pulp of jute" has yet been reported.

Jute was pulped by lime pulping at ambient temperature, the pulp was bleached by multistage bleaching using sodium borohydride and ambient temperature hydrogen peroxide process. The bleached and the treated paper samples were subjected to accelerated ageing for different periods of interval i.e., 1 to 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 cold lime pulping. Cationic starch was obtained from Spac Tapioca Products India Ltd, www.spacgroup.com, Precipitated calcium carbonate was obtained from S.D's Fine

Chemicals (Laboratory Rasayan).

Cold Lime pulping

Jute fibre was treated with 10 % Ca(OH)₂ on weight of material, at 1: 10 material to liquor ratio for 4-6 days. The yield of the pulp before bleaching was 85.8%.

Analysis of calcium carbonate and acid insoluble lignin :

Was done by gravimetric method and by TAPPI Test Methods (Technical Association of the Pulp and Paper Industry, New York), 1991 (T 222 om-88).

Bleaching of jute pulp

The pulp was given a partial beating treatment in the valley beater followed by the multistage bleaching process by borohydride followed by ambient temperature peroxide bleaching.

The cold lime 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 °C. The reductive bleaching treatment was followed by H₂O₂ oxidative bleaching. The pulp was washed thoroughly and treated at a material to liquor ratio of (1:2.5), using (100ml/L)

National Institute of Research on
Jute & Allied Fibre Technology
(ICAR)
12 Regent Park Kolkata 700040

H₂O₂, Trisodium phosphate (5g/L), NaOH (20 g/L) and sodium silicate (20 g/L) and kept in a sealed packet for 24 hrs. The pulp was thoroughly washed and treated with SO₂ water for 15 min. followed by washing with water.

Handmade paper and standard hand sheets

Standard hand sheets of about 60 GSM were made from the bleached pulps using (10 %) cationic starch (tapioca based) and in another case (15 %) precipitated calcium carbonate was added along with the cationic starch. The hand sheets were made in Universal Engineering Corporation hand sheet former.

Accelerated Ageing

Both the paper samples i.e., bleached pulp with cationic starch and the other sample with cationic starch along with precipitated calcium carbonate were sealed in air tight containers and subjected to accelerated ageing for different periods (1-5 days) in an oven at 100° C following the method adopted by at Preservation Research & Testing Division, Library of Congress, Washington DC, USA (4).

Evaluation of Physical Properties

Bursting Index was determined by Tappi Test Method - T 403 om-85, Folding endurance of paper (Schopper type) was determined by Tappi Test Method - T 423 Om-89 and Tearing strength were determined by Tappi Test Method - T 414 om-88. Double Fold Tester, Veb Werkstoffpriuima Schinen, Leiplig (Germany) and Bursting Strength Tester by Ubique Enterprises, Pune, were used.

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

The high yield cold lime pulp had an insoluble lignin content of 15.98%. The multistage bleached pulp samples were treated with 10 % cationic starch (tapioca based) and beaten in the beater before making the standard hand sheets. The same procedure was adopted followed by addition of 15 % precipitated calcium carbonate before making standard hand sheets in the second samples.

Based on the optical properties, pH and strength properties of the multistage bleached cold lime pulp of jute it was revealed that the cationic starch treated paper samples showed high ageing behaviour as was shown by the high negative Whiteness Index values, high Post Color Number values and low pH values (in the acidic range) beyond 2nd day of exposure (vide Fig. 1- 5).

Whereas, a low negative Whiteness Index value, low Post Color Number and high pH values (in the accepted basic range of permanent paper) beyond 2nd day of exposure, showed that the addition of precipitated calcium carbonated obliterated the negative effect of ageing on the bleached lime jute paper and made it a permanent paper. The values of the 457 nm brightness and the yellowness index corroborated the above findings (vide Fig. 1-5).

The above trend was also corroborated by the strength properties of the two samples as depicted in the Tables 1 and 2.

Conclusion

The cationic starch treated borohydride- hydrogen peroxide (ambient temperature) bleached jute paper was resistant up to 2 days of exposure

The corresponding samples treated with precipitated calcium carbonate are resistant beyond 2 days 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 samples treated (with precipitated calcium carbonate) thus show delayed ageing or increased permanence for the jute pulp bleached by the borohydride- hydrogen peroxide (ambient temperature) method.

References

1. www.handmadedpaper-kvic.com.
2. Hath Kagaz , Vol. 11 (7-9), July-Sept 2004.
3. Advances in agro processing & rural empowerment Institution of Engineers, Kolkata, 17-18 Feb. 2006. "Jute an alternative raw material for rural based handmade paper unit"- Roy A K , Ghosh I N, Chattopadhyay S N and Day A.
4. "The evolution of an new accelerated ageing test for paper" by Chandru J Shahani, Preservation Research and Testing Division, Library of Congress, Washington, DC, USA - Proceedings of International Conference

Table – 1
Effect of accelerated ageing on the strength properties of bleached lime jute paper
(* CAS= Bleached lime jute paper treated with cationic starch)

* CAS	G S M	Fold No.	Burst Index KPa.m ² .g	Tear Index m N. m ² .g
0 day	76	230	6.35	7.75
1 day	71	214	6.19	7.66
2 day	78	185	5.66	7.61
3 day	64	60	5.02	6.85
4 day	63	48	4.97	6.52
5 day	64	31	3.82	6.45

Table – 2
Effect of accelerated aging on the strength properties of bleached lime jute paper
(*CASC= Bleached lime jute paper treated with cationic starch + precipitated calcium carbonate)

* CASC	G S M	Fold No.	Burst Index KPa.m ² .g	Tear Index m N. m ² .g
0 day	71	225	5.93	7.21
1 day	73	220	5.64	6.92
2 day	71	215	5.38	6.80
3 day	79	210	4.49	6.68
4 day	72	184	4.46	6.57
5 day	74	172	4.10	6.48

Durability of Paper and Writing, 16-22 Nov., 2004, Ljubljana, Slovenia, p33.

5. TAPPI Test Methods (Technical Association of the Pulp and Paper Industry, New York), 1991, T-236 cm- 85, T-404-om-87, T 403 om-85, T 423 om-89, (T 222 om-88).
6. "Determination of pH of paper" - Kocar, D, Strlic, M, Kolar, J and Pihlar, B, - Proceedings of International Conference Durability of Paper and Writing,

16-22 Nov., 2004, Ljubljana, Slovenia, p26

7. "Effect of accelerated ageing on paper from cold soda pulp of jute" - A K Roy and S N Chattopadhyay - IPPTA J , Vol. 20(2)April-June 2008, 81-83
8. "Effect of accelerated ageing on ambient temperature bleached and dyed paper form cold soda pulp of jute"- A K Roy and S N Chattopadhyay - IPPTA J , Vol. 20(2)April-June 2008, 123-126.

9. "High permanence paper form jute" - A K Roy and S N Chattopadhyay - IPPTA J , Vol. 20(1) Jan Mar, 2008, 137-141

10. "A comparative study of ageing characteristic of jute based paper" - A K Roy and S N Chattopadhyay - INPAPER INDIA Vol.10 (6) Nov-Dec, 2007, 50-54.
11. "Jute Data Book"- B C Mitra, NIRJAFT (ICAR), Kolkata (1990).

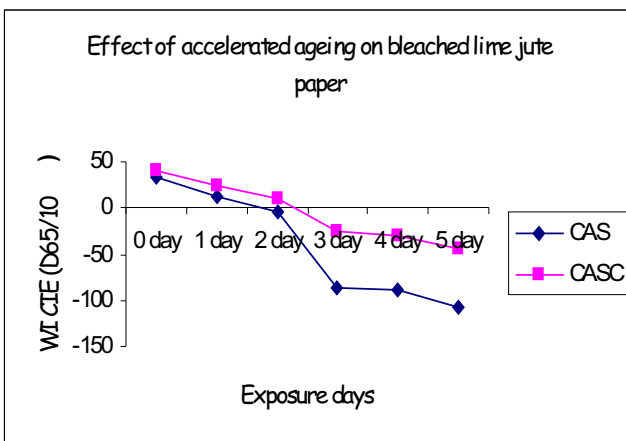
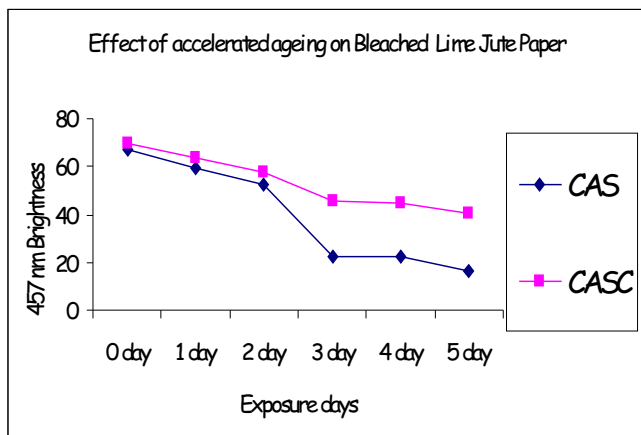


Fig 1 & 2 Effect of accelerated ageing on 457 nm brightness and W.I. of bleached lime paper of jute

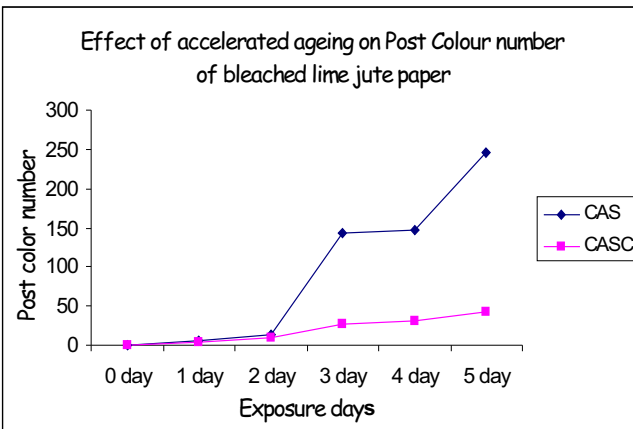
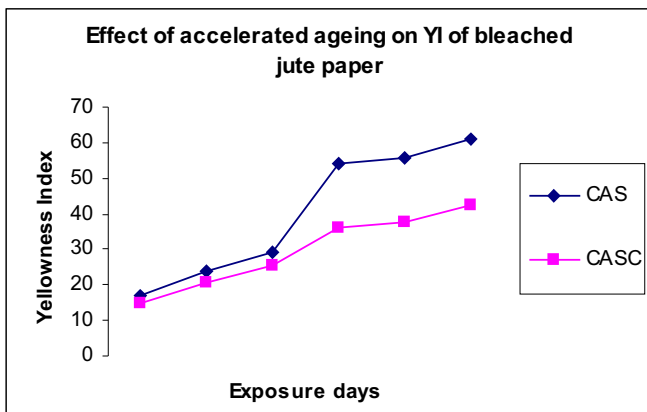


Fig 3 & 4 Effect of accelerated ageing on Y.I. and Post color No. bleached lime paper of jute

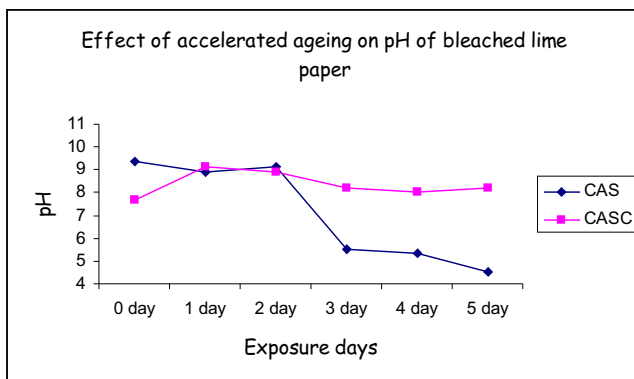


Fig. 5 Effect of accelerated ageing on pH of bleached lime paper of jute

*CAS = Bleached lime jute paper treated with cationic starch

*CASC= Bleached lime jute paper treated with cationic starch + precipitated calcium carbonate