REPORT

Canadian Conservation Institute
Institut canadien de conservation

Evaluation of Provenance PaperSaver Deacidification Spray

for

Provenance, LLC
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Canada

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We ensure client satisfaction through:

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  - new conservation knowledge and practices
  - care of collections and preventive conservation
  - treatment of artifacts and works of art in Canadian museums, art galleries, archives and libraries
  - materials or condition of heritage objects to improve the understanding of collections
  - museum facilities and planning
  - transportation for fine arts and artifacts

- collaborating with regional, provincial, territorial, national and international cultural communities, institutions and related agencies including conservation associations and the private heritage sector

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Introduction

Provenance LLC has developed a family of products called PaperSaver that incorporates a paper deacidification treatment based on a combination of alkaline oxides and carbonates for spray application. Dr. Joseph Zicherman, CEO, Provenance LLC, requested that the Canadian Conservation Institute carry out an independent evaluation of the PaperSaver deacidification spray.

Experimental

Samples

An acid paper (8.5" x 11" sized sheets) watermarked "The University of Michigan" was sent to CCI for the evaluation. Four 10oz (283 g) cans of PaperSaver deacidification spray were also supplied. The samples were treated (spray deacidified) at CCI as per instructions provided by Provenance LLC. After treatment, samples were conditioned for 30 days before aging and testing was started.

Treatment conditions:

A: sample sprayed on one side of page (single side)
B: sample sprayed on both sides of page (double side)

Accelerated aging procedure

The accelerated aging was carried out in controlled temperature and humidity chambers (ESPEC PRA-3GP). Samples were aged in sealed glass tubes at 90°C for 14 days according to ASTM test method D6819-02 (Standard Test Method for Accelerated Temperature Aging of Printing and Writing Paper by Dry Oven Exposure Apparatus). Additional aging intervals (2, 5, 9, and 20 days) were required for the untreated acid paper to provide a good baseline used to determine the relative stability of the treated versus untreated sample. After aging, the papers were conditioned for testing according to TAPPI standard T 402 om-88.

Physical Properties

An Elmendorf tear tester was used to measure the tearing resistance as described in TAPPI standard T 414 om-88. The folding endurance was determined using the M.I.T. apparatus according to TAPPI standard method T 511 om-88 with a tension of 500g instead of the standard 1kg. The zero-span tensile strength measurements were performed according to TAPPI standard T231 cm-85 using a Pulmac Troubleshooter Instrument. ISO Brightness, yellowness and colour (L*a*b*) were measured using an Elrepho 2000 spectrophotometer (D65/10°). The grammage was determined according to TAPPI standard T 410 om-88. The thickness, or caliper, was measured according to TAPPI standard T 411 om-89. Test strips were taken from 8 sheets for each sample.

Chemical Properties

Moisture content was determined according to TAPPI standard T 412 om-90. The cold extraction pH of the paper was measured in accordance with TAPPI standard T 509 om-88. The amount of alkaline reserve in the papers was measured by the method outlined in ASTM standard D 4988-89. The procedure was modified by determining the endpoint of the titration potentiometrically rather than by the use of an indicator. Also, instead of breaking up the samples in a blender and subsequently boiling them for one minute, they were cut into small pieces (5mm x 5mm) to which the water and 0.1N HCl was added. This sample solution was then left overnight and the titration using 0.1N NaOH was performed the following day. This modification allowed the pH and alkaline reserve to be determined on the same sample therefore reducing the amount of sample used.

Results

Results of the testing are summarized in Tables 1-1 to 1-2, and Figures 1-1 to 1-2 .

The acid paper (The University of Michigan) provided by Provenance LLC proved to be an excellent sample for this study. With a starting pH of 5.42, it degraded significantly over the 14 day aging period. For example, there was a 99.6% loss in double folds and a 62.8% loss in tear strength after 14 days of aging (Table 1-1).

Both of the treatments (single and double side) had little effect on the initial (unaged) properties of the paper (other than pH and alkaline reserve) and improved the aging stability (Table 1-2). The relative improvement was determined using the fold endurance and tear data. The values at 14 days of aging for the treated samples were plotted on the graphs for the untreated acidic sample (Figures 1-1 and 1-2). The equivalent values were found on the curves for the untreated sample and the time axis co-ordinates for those points provided the number of days that the untreated sample would require to reach those values. For example (Figure 1-1), after 14 days of aging, the fold endurance was reduced to 341 double folds (single side deacidification) and 331 double folds (double side deacidification). The same values of 341 and 331 double folds would have occurred in approximately 4.5 days for the untreated sample. Since the ratio of 14 days (treated) to 4.5 days (untreated) is 3.1, the relative stability was improved by a factor of three.

After 14 days of aging, the tear index was reduced to 7.24 mNm^2/g (single side deacidification) and 7.25 mNm^2/g (double side deacidification) (Figure 1-2). These values were reached at 4.3 days for the untreated sample. Therefore, the relative stability was improved by a factor of three.

Therefore, the results indicate that the PaperSaver deacidification spray improved the stability of the acid paper by a factor of three for both the single side and double side applications.

Table 1-1: Test results for the accelerated aging of acid paper (The University of Michigan)

Property	untreated acid paper (The University of Michigan)					
	unaged	aged 2 days	aged 5 days	aged 9 days	aged 14 days	aged 20 days
Grammage (g/m²)	74.90	74.46	74.26	73.84	73.46	73.82
Grammage (oven dry) (g/m²)	70.27	70.28	70.32	70.03	69.75	70.30
Moisture content (%)	6.18 ± 0.04	5.61 ± 0.01	5.30 ± 0.03	5.16 ± 0.04	5.05 ± 0.06	4.77 ± 0.06
Caliper (mm)	0.116 ± 0.000	0.115 ± 0.001	0.116 ± 0.001	0.115 ± 0.000	0.115 ± 0.000	0.115 ± 0.000
Cold extraction pH	5.42 ± 0.02	5.13 ± 0.02	4.92 ± 0.02	4.72 ± 0.01	4.58 ± 0.01	4.46 ± 0.01
Alkaline reserve (as % $CaCO_3$)	-	-	-	-	-	-
Tear (CD) (mN)	662.9 ± 14.8	578.8 ± 21.2	487.7 ± 17.7	360.2 ± 9.3	246.7 ± 11.9	165.4 ± 20.0
Tear index (CD) (mNm²/g)	9.43 ± 0.21	8.24 ± 0.30	6.93 ± 0.25	5.14 ± 0.13	3.54 ± 0.17	2.35 ± 0.28
Fold endurance (MD) (0.5 kg) (double folds)	955 ± 151	633 ± 112	294 ± 52	62 ± 12	4 ± 1	1 ± 0
Fold endurance (MD) (0.5 kg) (log of double folds)	2.97 ± 0.07	2.79 ± 0.08	2.46 ± 0.08	1.79 ± 0.08	0.63 ± 0.11	0.00 ± 0.00
Zero-span breaking length (km)	13.31 ± 0.78	12.36 ± 0.47	11.16 ± 0.52	9.38 ± 0.41	7.85 ± 0.31	6.38 ± 0.49
Brightness (% reflectance)	91.73 ± 0.28	81.60 ± 0.63	74.38 ± 0.73	68.43 ± 1.13	58.97 ± 0.77	53.11 ± 1.23
Yellowness	2.39 ± 0.22	9.54 ± 0.47	14.15 ± 0.43	18.10 ± 0.82	24.45 ± 0.55	29.19 ± 0.76
L*	97.04 ± 0.06	94.78 ± 0.16	92.72 ± 0.26	90.85 ± 0.37	87.48 ± 0.34	85.30 ± 0.62
a*	0.6 ± 0.1	1.0 ± 0.0	1.5 ± 0.1	1.8 ± 0.1	2.6 ± 0.1	3.1 ± 0.2
b*	1.0 ± 0.1	4.6 ± 0.2	6.8 ± 0.2	8.7 ± 0.4	11.5 ± 0.2	13.6 ± 0.3

Note: - accelerated aging was carried out in sealed glass tubes at 90°C

- ± indicates standard deviation

Table 1-2: Test results for the accelerated aging of acid and deacidified paper (The University of Michigan)

Property	untreated acid		deacidified (single side)		deacidified (double side)	
	unaged	aged 14 days	unaged	aged 14 days	unaged	aged 14 days
Grammage (g/m^2)	74.90	73.46	75.92	75.31	76.06	75.33
Grammage (oven dry) (g/m^2)	70.27	69.75	71.14	71.14	71.39	71.29
Moisture content (%)	6.18 ± 0.04	5.05 ± 0.06	6.30 ± 0.02	5.54 ± 0.02	6.15 ± 0.07	5.36 ± 0.00
Caliper (mm)	0.116 ± 0.000	0.115 ± 0.000	0.116 ± 0.000	0.117 ± 0.000	0.117 ± 0.000	0.116 ± 0.000
Cold extraction pH	5.42 ± 0.02	4.58 ± 0.01	9.04 ± 0.14	8.18 ± 0.22	9.15 ± 0.06	8.77 ± 0.01
Alkaline reserve (as % $CaCO_3$)	-	-	0.52 ± 0.09	0.26 ± 0.15	0.68 ± 0.06	0.42 ± 0.02
Tear (CD) (mN)	662.9 ± 14.8	246.7 ± 11.9	650.3 ± 9.3	515 ± 5.4	648.9 ± 13.2	516.7 ± 5.1
Tear index (CD) (mNm^2/g)	9.43 ± 0.21	3.54 ± 0.17	9.14 ± 0.13	7.24 ± 0.08	9.09 ± 0.18	7.25 ± 0.07
Fold endurance (MD) (0.5 kg) (double folds)	955 ± 151	4 ± 1	840 ± 102	341 ± 75	787 ± 147	331 ± 57
Fold endurance (MD) (0.5 kg) (log of double folds)	2.97 ± 0.07	0.63 ± 0.11	2.92 ± 0.05	2.52 ± 0.10	2.89 ± 0.08	2.51 ± 0.08
Zero-span breaking length (km)	13.31 ± 0.78	7.85 ± 0.31	13.22 ± 0.50	11.81 ± 0.50	13.23 ± 0.60	11.87 ± 0.29
Brightness (% reflectance)	91.73 ± 0.28	58.97 ± 0.77	91.86 ± 0.09	60.50 ± 2.35	92.11 ± 0.23	63.25 ± 0.48
Yellowness	2.39 ± 0.22	24.45 ± 0.55	2.33 ± 0.05	24.91 ± 2.53	2.09 ± 0.29	22.28 ± 0.57
L*	97.04 ± 0.06	87.48 ± 0.34	97.07 ± 0.02	88.59 ± 0.59	97.10 ± 0.02	89.37 ± 0.12
a*	0.6 ± 0.1	2.6 ± 0.1	0.6 ± 0.0	2.3 ± 0.1	0.6 ± 0.1	2.0 ± 0.0
b*	1.0 ± 0.1	11.5 ± 0.2	1.0 ± 0.0	12.0 ± 1.3	0.9 ± 0.2	10.7 ± 0.3

Note: - accelerated aging was carried out in sealed glass tubes at 90℃

- ± indicates standard deviation

Figure 1-1: Folding endurance (0.5 kg) as a function of aging time
Acid paper (The University of Michigan)

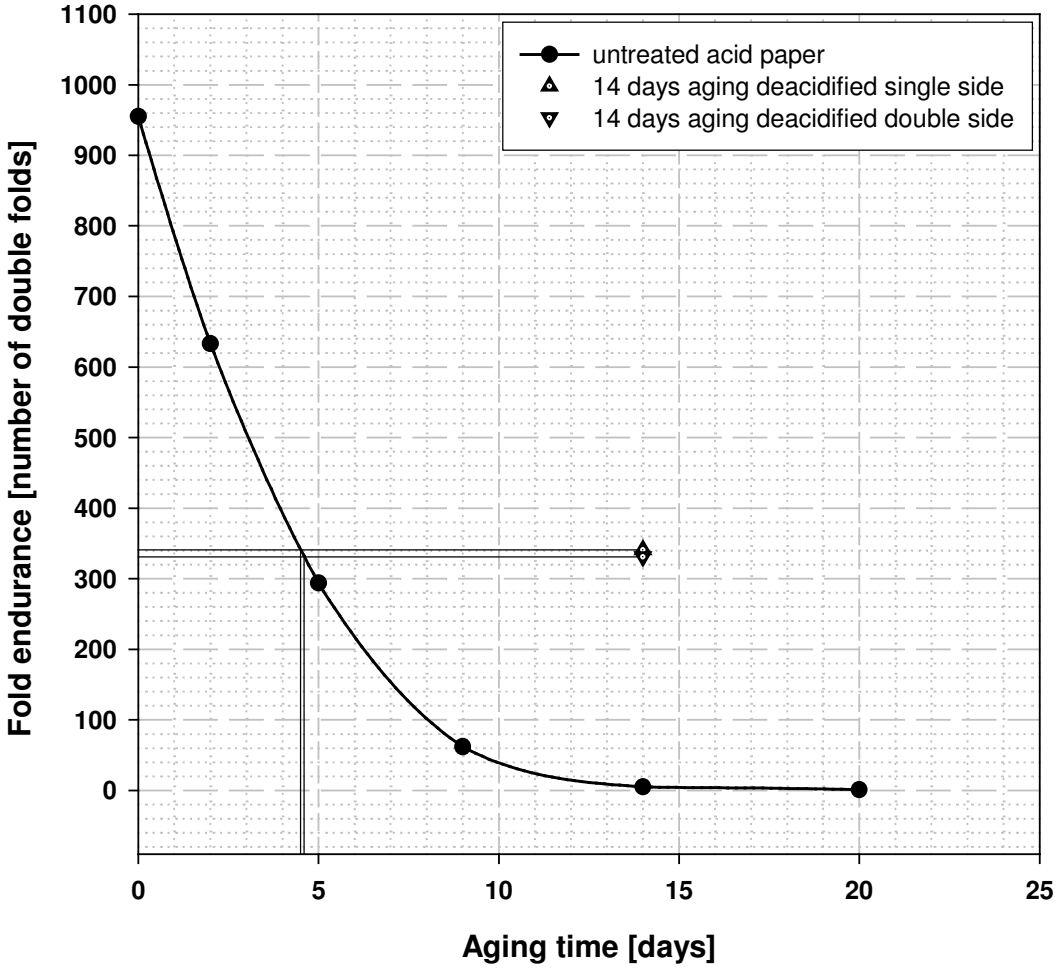

Figure 1-2: Internal tearing resistance as a function of aging time

Acid paper (The University of Michigan)