Informe de evaluación del proceso CSC Book Saver®

Adjuntamos el informe de la evaluación del proceso CSC Book Saver® realizado por el Dr. Banik.

El Dr. Banik, profesor de la Staatlichen Akademie der Bildenden Künste Stuttgart (Academia Estatal de Arte y Diseño de Stuttgart, Alemania) es uno de los expertos más prestigiosos a nivel mundial en el campo de la preservación de patrimonio escrito. En 2002 dirigió el estudio “Criterios para la toma de decisiones sobre la aplicabilidad de tratamientos de desacidificación en masa”, sufragado por una fundación alemana para la investigación, en el cual se investigaban no solo la efectividad sino también las posibles contraindicaciones de los más avanzados tratamientos disponibles en la actualidad.

Para la evaluación del proceso CSC Book Saver® se ha seguido el mismo protocolo, al objeto de que los resultados sean comparables.

Los criterios de calidad utilizados para la interpretación de los resultados son los recientemente presentados en la Norma Suiza de Calidad titulada “Quality standards for the use of the papersave-swiss-process for the neutralization of materials of the Swiss National archive and the National Agency for Culture, Swiss State Library”. En dicha norma se recogen los parámetros a evaluar, los valores especificados, los métodos de ensayo y los procedimientos de análisis.

El material de test, seleccionado y homologado conforme a procedimientos estandares, fue tratado en las máquinas que CSC tiene instaladas en la empresa PAL de Leipzig, licenciataria de CSC para la prestación de estos servicios en Alemania.

Los ensayos analíticos fueron realizados en laboratorios certificados, con experiencia en la realización de estos análisis. Los ensayos ópticos y táctiles fueron conducidos por el personal de la Marburg University Library. La interpretación final de resultados se realizó en la Academia Estatal de Arte y Diseño de Stuttgart. Todo el proyecto se realizó bajo la dirección del Dr. Banik.

El trabajo del Dr. Banik y su equipo representa un excelente trabajo de investigación, destacando su esfuerzo en desarrollar, y aplicar con el máximo rigor, normas y procedimientos estandares que permitan evaluar el estado actual de los tratamientos de desacidificación en masa, sus condiciones idóneas de aplicación, y muy significativamente, como avanzar en las condiciones de prestación del servicio.

En las conclusiones de la evaluación (página 19/20) se destaca que: “Sobre la base de este estudio, se puede afirmar que el proceso CSC Book Saver ® es un sistema de desacidificación en masa eficiente y altamente desarrollado que proporciona un tratamiento de alta calidad a la mayoría de los materiales de biblioteca y archivo. Este estudio demuestra que los resultados que se pueden conseguir con este proceso CSC Book Saver® son comparables a aquellos alcanzados por Papersave Swiss (NCW), que es el proceso de desacidificación en masa más eficiente y fiable en la actualidad.”

CSC Conservación de Sustratos Celulósicos S.L.

Evaluation of the efficacy of CSC- Booksaver® Process for the deacidification for archives and library materials, based on test treatments at the Preservation Academy Leipzig (PAL)

This report presents a summary of the results of three deacidification treatment test trails. Three batches of materials were treated separately (16th and 19th of January 2004) using the deacidification equipment of the Preservation Academy. Scientific analysis and evaluation were carried out by independent institutions.

INTRODUCTION

The CSC (Conservacion de Sustratos Celulósicos) Booksaver® is available in Germany since 2003 as one of the contemporary mass deacidification methods for library and archives materials (a pilot plant went into operation in Spain 1999). CSC- Booksaver® is a liquid-phase treatment. The carrier fluid is a liquefied gas (1,1,1,2,3,3,3-heptafluoropropane or HFC 227), and the deacidificant is carbonated magnesium propylate (n-propoxypropylmagnesiumcarbonate). In recent years, Booksaver® has been tested repeatedly in different trials, including the treatment of

- archives materials in Bilbao, Spain (2001)
- library materials in Taormina, Italy (2002/2003)
- library materials in Berlin, Germany (2003).

Among the different deacidification methods, the CSC-Booksaver® Process is most closely related to the PAPERSAVE® Process, but differs from it in several important respects:

- The deacidicant of Booksaver (carbonated magnesium propylate) is distinctly less sensitive to the inadvertent exposure to water than the deacidificant employed by PAPERSAVE® (magnesium- titanium-alcoholate or METE30 in hexamethyldisiloxane).
- Because of the lower water-sensitivity of the Booksaver deacidificant, the materials to be treated do not have to undergo the intensive desiccation
- necessary for the PAPERSAVE® treatment. For Booksaver®, it is usually sufficient to cool the materials before treatment so that they hold less water. Only in special cases is it necessary to pre-condition the materials for 12-24 hours in a chamber set at 45-50°C until they reach a moisture content of 2%.
- Booksaver does not employ a flammable carrier fluid.
- The Booksaver® equipment is small in size, designed for the treatment of 40 kilograms of materials per batch.

Because of its low toxicity and low water sensitivity, and, importantly, the small size of the equipment, Booksaver® is suitable for installation in collection institutions which allows convenient in-house operation.

EVALUATION METHOD

The strategy for the evaluation of the CSC-Booksaver® Process was based on a previous evaluation of the PAPERSAVE® Process that had been funded by a German research foundation, the Deutsche Forschungsgemeinschaft (DFG). The results of that earlier project had been presented in a report entitled “Kriterien zur Entscheidung über die Anwendbarkeit von Massenkonservierungsverfahren” (“Criteria for making decisions about the applicability of mass deacidification treatments”) (Final Report of DFG III N2-55722/98, Part 1-3, Stuttgart 2002). It is important to note that this evaluation did not only concern the effectiveness of the deacidification reagent, but also presented a statistically valid analysis of treatment side effects. The results of the PAPERSAVE® and Booksaver® testing can be compared because of they both followed the same protocol.

Testing of the effectiveness of the deacidificant was conducted as follows:[1]

Test Papers

Two test paper were selected for treatment and subsequent destructive analysis. One of them had been used in the earlier DFG study (III N2-55772/98). That paper was an industrial woodpulp (48% chemical, 52% groundwood) paper produced in the 1970s that was sized with alum-rosin. The second test paper is also an acid-sized wood pulp paper (25-25% sulfite, 50-60% groundwood, 12-15% China clay). It has been selected as a test paper by a DIN Commission involved with the standardization of quality control for mass deacidification. This paper was ideal for the testing of Booksaver® because it is designed to undergo regular deacidification treatment together with other materials, and subsequently can be (destructively) analyzed for the efficacy of the treatment (Novo, 90g/m^2, Klug Conservation). In the following report, the paper that had been also used during the DFG project will be referred to as **DFG Paper**, and the deacidification control paper will be referred to as **PAL paper**. Technical information about the two test papers can be found in Appendix 1.

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[1] As part of the DFG Project, a new method had been developed for analyzing deteriorated paper for the extent of cellulose degradation. This method consists of identifying and quantifying furfural, acetic acid and hexanal released by paper during *ageing* in the degraded cellulose. These key substances are indicative of the acid and oxidative cellulose degradation. At the time of the current project, however, the method was not yet available at commercial analytical laboratories, and so was not used in this study.

Analytical Testing Methods

The distribution of the deacidificant magnesium in the treated paper samples was analyzed with inductive coupled plasma atomic (optical) emission spectroscopy [ICP/OES)]. This method requires preparation of the paper samples through hot extraction in 20% hydrochloric acid. The extraction process is designed to separate the magnesium introduced to the paper during the deacidification treatment from any magnesium that might be naturally present in the paper, for example in the form of fillers. This way, the China clay present in the PAL paper, and the Kaolin present in the DFG paper did not interfere with the analysis of the Booksaver deacidification (i.e. the distribution of the alkaline reserve across the paper sheet).[2] However, it should be noted that this form of analysis is destructive and therefore only suitable for expendable sample material.

Because each test sample required only a very small amount of material (0.15 g), it was possible analyze 7 different areas across each individual paper sheet. This made it possible to map the distribution of the deacidification agent across the paper sheet. The alkaline reserve is expressed as magnesium carbonate.

Criteria for Evaluation of Results

Criteria for the interpretation of the analytical testing follow those recently presented in a Swiss Quality Standard entitled “Qualitätsstandards für die Neutralisierung der Materialien des Schweizer Bundesarchivs und des Bundesamts für Kultur, Schweizerische Landesbibliothek nach dem papersave swiss-Verfahren” (Quality standards for the use of the papersave-swiss-process for the neutralization of materials of the Swiss National archive and the national agency for culture, Swiss state library) (report from May 18, 2004, see Appendix 8).

Alkaline reserve:

The Swiss Quality Standard details that paper artifacts are deacidified if they

- Have a surface pH ≥ 7.0 (according to NCW regulation PAW 6074)
- Have an extract pH ≥ 7.0 (according to DIN 53124)
- Their wet chemistry analysis gives a positive result for the presence of alkali content (DIN ISO 10716).[3]

[2] By comparison, XRF cannot differentiate between magnesium that is present in the paper as a deacidificant and as a paper filler.
[3] Section 4.1 of Swiss Report

According to the Swiss Quality Standard, the treatment is successful if 95% of the test papers and original papers sampled for testing achieve the following values:

- 0.5 - 2.0% magnesium carbonate content in the test papers
- 0.3 – 2.3% magnesium carbonate content in original papers.[4]

It is important to note that the Swiss Quality Standard also requires a limit at the high end for the alkaline reserve deposited. This regulation takes into account that higher concentrations of magnesium carbonate (up to 4%) can, over time, lead to a reduction of paper strength (Blüher 2003).

Color change

Another criteria for the success of the deacidification treatment concerns the color change permissible for the treated paper. In the Swiss Quality Standard, the permissible color change was defined colorimetrically in the CIE L*a*b* space (a three-dimensional model in which color is recorded numerically by its red-green [a*], blue-yellow [b*] and brightness [L*] component). The color change experienced by the reference test paper treated alongside the original material should not exceed the following values after treatment.[5] A mean value for the overall color change permissible in the reference paper lies within the center of the three-dimensional color space defined by these numbers.

Values not to be exceeded for color change of test papers:

- $\Delta L^* = \pm 1.5$
- $\Delta a^* = \pm 0.5$
- $\Delta b^* = \pm 2.0$

Values preferably not to be exceeded for color change of original papers:

- $\Delta L^* = \pm 2.0$
- $\Delta a^* = \pm 1.0$
- $\Delta b^* = \pm 3.5$

[4] Section 4.2 of Swiss Report
[5] Section 4.4 of Swiss Report

Table 1: Analytical Test Methods, their standard procedures and norms

type of test	testing standard	testing method	standard deviation
distribution of magnesium carbonate	DIN EN ISO 11885 EN 22	ICP/AOES 7 sampling areas per sheet	± 0.01% $MgCO_3$
surface pH	PAW 6074	pH measurement	± 0.3 units
extract pH	PAW 101314	DIN 53124	± 0.15 units[6]
Acid content (alkali absorption)	PAW 6069*	Titration	± 0.04% $MgCO_3$
Color values	PAW 6075*	Spectroscopy	L* = ± 0.05 a* = ± 0.02 b* = ± 0.02[7]
Alkaline reserve	PAW 6072	ISO 10716	± 0.12% $MgCO_3$

* see Testing Reports of Nitrochemie Wimmis AG, Niesenstrasse 44, CH 3752 Wimmis, Switzerland

Optical and tactile properties

The optical and tactile properties were evaluated according to methods developed during the DFG project (see the DFG Final Report, Vol. 2, 2002). These methods are designed to standardize and objectify the evaluation of the side effects of deacidification treatment. They define a so-called "risk indicator" (Risikokennzahl). The risk indicator is calculated from observations recorded by a group of evaluators. The risk indicator identifies the degree of change permissible in the treated paper.

Institutions Involved in the Testing Phase

The papers were treated in the CSC-Booksaver® equipment at the Preservation Academy in Leipzig. Analytical tests were conducted by certified laboratories that were well acquainted with the methods required by the project.

The optical and tactile properties of the treated papers were conducted by the staff of Marburg University Library, with the participation of student library assistants who acted as trained, independent evaluators. Final interpretation of the results was carried out at the State Academy of Art and Design Stuttgart.

[6] Based on an estimation of the range of values expected.
[7] The standard deviation the CIE L* a* b* values was estimated with the aid of the Q card.

Selection and Documentation of Samples

The materials that were to be deacidified were selected by Mrs. Ulrike Hähner, chief conservator and head of the preservation office at the Marburg University Library. Forty-seven volumes were chosen from a special collection of the Library devoted to books about the State of Hessia. The same collection had already served the previous deacidification research project sponsored by the DFG (see the DFG Final Report, vol. 2, 2002, p. 17). That collection was chosen because it bears many characteristic features of a typical library or archives collection:

- high artifactual value due to the historical significance of individual items
- largely produced with paper post-dating the year 1800, containing alum-rosin sizing and ligneous wood pulp; these contribute to the acid hydrolysis of cellulose
- diverse formats that include books made with a variety of binding techniques and materials; a high proportion of brochures, leaflets, and single sheets
- presence of a variety of writing media in the form of handwritten notes; collection stamps; and various forms of copy techniques
- original photographs and printed illustrations as part of publications.

Artifacts were selected according the damage categories developed by the Marburg University Library preservation office. The artifacts chosen matched an intermediate damage category (II) that falls between undamaged and severely damaged. Category II includes materials that show “damage of medium severity, that are on the way of becoming unstable, that show distinct signs of discoloration, and have to be preserved in the original format due to their high artifactual value.” The artifacts chosen for the evaluation of Booksaver® were selected to cover the same variety of materials and media that had been evaluated during the PAPERSAVE® trial of DFG-sponsored deacidification evaluation (DFG Final Report, vol. 2, 2002).

Red cloth and other colored binding materials that were known to be prone to bleeding during non-aqueous deacidification treatment were wrapped in protective paper covers that prevented the migration of soluble dyes into adjacent artifacts. In addition, barrier papers were interleaved in books that contained stamps or other potentially sensitive media to prevent them from bleeding onto adjacent pages. The same kind of precautions had been taken during the DFG-sponsored testing of PAPERSAVE® (DFG Final Report, vol. 2, 2002, 17, section 8).

The artifact sample collection was documented before and after deacidification according to the system that had been employed for the documentation of artifacts during the DFG project (DFG Final Report, vol. 2, 2002, 19-21). The documentation included identifying information such as signature, publication year and binding style, as well as data on the pre- and post-treatment condition.

To collect these data, each artifact had to be inspected individually. Methods of data handling were identical with those employed during the DFG project so that they could be easily compared.

TREATMENT

In preparation for the deacidification treatment, the selected artifacts were divided into three batches, each of which contained:

- two or three bindings covered in red of green cloth
- three books with cloth spines and paper covers in red, green, brown or black
- one calico cloth binding (monochrome or multi-colored)
- a collection of brochures covered in cardboard and sewn through the center fold
- two cardboard leaflets
- one or two paper bindings
- several simple bindings from different materials (cloth or paperbacks with cardboard covers); many of these were brochures that had been covered with a library case binding over their original paper binding
- two dissertations, DIN A4 (equivalent to US letter size) with paper spines and board covers; individual pages of these publications feature special copying processes and original photographs.

Additional materials were added to each batch:

- One specially made test book constructed of sheets of PAL paper and DFG paper; this book was later analyzed for the distribution of deacidificant within a book structure. The structure of the test books and the sampling strategy for analytical testing are described in Appendices 2 and 4.
- All of the books were interleaved with sheets of the PAL paper. A selection of these interleaved sheets was also analyzed in the same manner as the samples from the test book.

Batch Number 3 received two deaccessioned books published in 1884. Papers from these books were subjected to the same analytical testing as the PAL paper.

The selected materials were treated in three batches using the deacidification equipment of the Preservation Academy Leipzig. The material was preconditioned for 24 hours in a 50% RH environment. This treatment reduced the moisture content of the materials (information provided by PAL):

Batch 1	1.75%
Batch 2	1.83%
Batch 3	2.05%

The deacidification treatment time for each batch was 2 hours 45 minutes.

RESULTS

Table 2 summarizes the results of the destructive analytical testing. It included the determination of cold extract pH, alkaline reserve, and acid content (alkali absorption) as well as the spectroscopic analysis of color change. Testing procedures adhered to the standard methods listed in Table 1. Samples that underwent these analyses were PAL and DFG papers from batches 1 and 3, and the historic papers taken from the expendable books added to batch 3 (labeled "OR" in table).

The data demonstrate that the CSC-Booksaver® Process meets the requirements of an effective deacidification agent:

- All of the papers were deacidified.
- The pH value obtained from cold extraction lies at a mean of 8.19 and a maximum of 9.06 (satisfies the Swiss Quality Standard 4.1).
- The alkaline reserve, expressed as %, lies in the positive range (Swiss Quality Standard 4.1).
- The papers do not show significant color change. The colorimetric data collected for the test papers and original papers are within the required range (Swiss Quality Standard 4.4)

Table 2: Summary of the results of analytical testing of the DFG paper, PAL paper, and original samples (OR)

paper and sample location*	extract pH	alkaline reserve % MgCO3	acid content % MgCO3	ΔL*	Δa*	Δb*	ΔE*ab
1 PAL F+3	8.63	0.68	0.02	-0.20	-0.03	-0.96	0.98
1 PAL F-3	9.06	0.69	0.03	-0.11	0.06	-1.08	1.09
1 DFG M+2	8.55	0.48	-0.21	0.22	-0.22	0.94	0.99
1 DFG M-2	8.74	0.54	-0.15	-0.73	0.17	1.27	1.47
1 PAL B+10	8.73	0.66	0.00	-0.25	-0.11	0.02	0.27
1 PAL B-10	8.84	0.69	0.03	-0.17	0.07	-0.92	0.94
3 PAL V+3	8.46	0.35	-0.31	-0.21	-0.09	0.15	0.27
3 PAL V-3	8.56	0.42	-0.24	-0.27	0.07	-0.87	0.92
3 DFG M+2	8.39	0.46	-0.23	0.64	-0.39	0.42	0.86
3 DFG M-2	8.19	0.32	-0.37	-0.55	-0.01	0.99	1.13
3 PAL B+10	8.49	0.78	0.12	-0.31	0.07	-0.81	0.87
3 PAL B-10	8.57	0.64	-0.02	-0.20	-0.16	0.19	0.32
OR F	8.74	0.54	--	--	--	--	--
OR M	8.73	0.34	--	--	--	--	--
OR B	8.65	0.34	--	--	--	--	--
Testing protocol	DIN 53124	ISO 10716	as described in the Testing Report from Nitrochemie Wimmis AG, Appendix 5				

* location of sampling on sheet:: F=front; M=middle; B=back

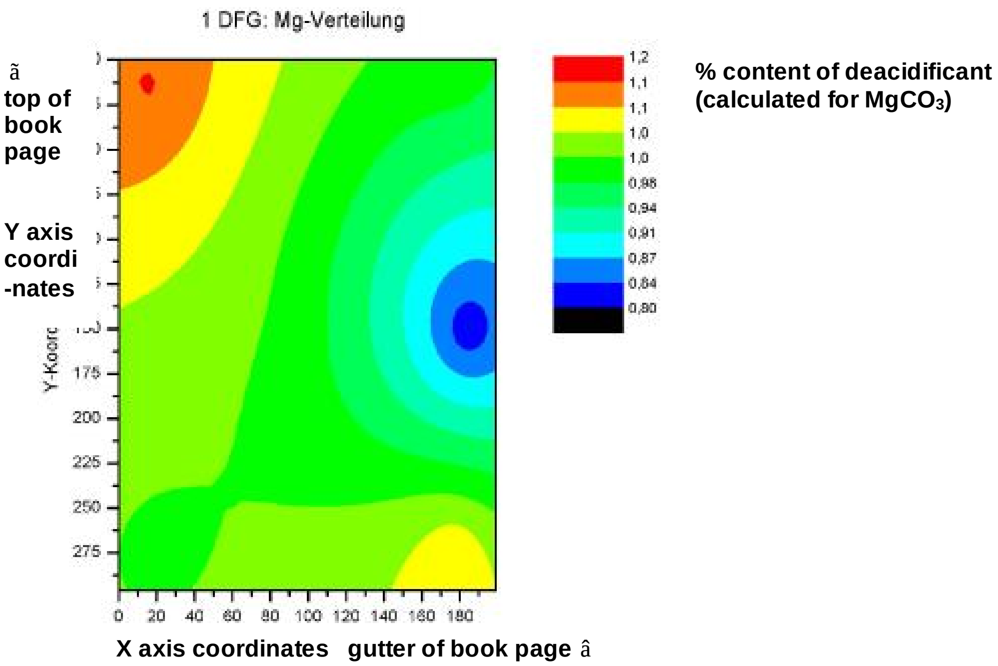
Distribution of the alkaline reserve

The ICP/OES analysis demonstrated that the distribution of $MgCO_3$ across the expanse of the paper sheet was not entirely homogeneous. An example of a typical distribution of deacidification agent across a sheet can be seen in Fig. 1 (the complete set of data concerning the distribution of $MgCO_3$ can be found in Appendix 6). The more or less inhomogeneous distribution of the deacidification agent (ranging between 1.2% - 0.8% $MgCO_3$) is, however, not unusual for liquid deacidification systems, as initially observed by Daniel and Flieder in 1994, and subsequently noted in other publications on archives- and library deacidification. Taking into account that liquid deacidification always produces a more or less uneven distribution of deacidification agent, the results of the Booksaver® treatment can be regarded as falling within the expected range.

The observed variation in the deposit of alkaline reserve fall within the limits set by the Swiss Quality Standard and therefore can be regarded as normal. It can be noted that the degree of variation in the deposit of the deacidification agent during liquid phase treatment depends to some extent on treatment parameters. The pre-drying step is important (especially for PAPERSAVE®).

It also matters how densely the materials are packed during deacidification, how the deacidification solution is introduced into the chamber, and how the liquid is evacuated at the end of the treatment (important for both Booksaver® and PAPERSAVE®).

Fig. 1: Distribution of CSC-Booksaver® deacidification agent across the treated DFG test paper (bound into a test book, part of batch 1). The distribution was determined with ICP/OES on 7 measuring points. The concentration of $MgCO_3$ varies by 0.3% across the page (see also table 3.a).



With regard to the minimum and maximum amount deposited in the PAL and DFG test papers bound into a test book, the $MgCO_3$ content of the papers only in a few cases fell below the 0.5% limit set in the Swiss Quality Standard (report of May 2004, section 4.2), and never exceeded it. This can be noted especially for batch number 3. In 33% of the sites samples for testing, which were mostly located in the gutter of the book, the $MgCO_3$ content lay below the 0.5% set by the Swiss Quality Standard. In most of these cases, the deviation was, however, very small. Of the 33% that fell below the 0.5% limit,

71% fell short by ≤ 0.10% $MgCO_3$
48% fell short by ≤ 0.05% $MgCO_3$.

It is interesting to note that the PAL papers that had been inserted into original books never fell short of the required standard, except in one case. And in case of the few original papers that could be sampled (labeled OR in Table 2), only one test site recorded a $MgCO_3$ content below the Swiss Quality Standard (0.45%). The complete data of all the tests are presented in tables 3g and 3h.

All of the analyses are well reproducible. Even the standard deviation of batch 3 lies within the confidence range. With regard to the minimum deacidificant required, only the low-end values for batch 3 are significant. However, the low deacidificant concentration was recorded only in the test papers bound into test books, and did not concern the PAL test papers inserted into original books, and the naturally aged papers from small-sized original book. This indicates that the treatment of batch 3 differed from the normal deacidification operation.

Table 3:
Summary of all the analytical data (collected through ICP/OES) concerning the distribution of alkaline reserve

Table 3.a: Test book, batch 1, first data acquisition

DFG	PAL		Original
1,12	0,92	0,81	Not analyzed
0,99	0,94	0,84	
1,04	***0,46***	***0,2***	
1	0,74	0,92	
0,8	0,85	1,1	
1	***0,45***	0,77	
1,08	1,04	1,45	

all numbers: 21 measuring locations, 5% equals one measuring location (1.05)
italics numbers: 3 measuring locations unsatisfactory, equals 14%; unsatisfactory

Table 3.b: test book, batch 1, second data acquisition

DFG	PAL		Original
0,89	0,8	0,7	Not analyzed
0,88	1,02	1,24	
0,84	***0,3***	0,53	
0,92	0,76	0,61	
0,63	1,22	0,77	
0,89	0,67	0,72	
0,89	1,09	0,59	

all numbers: 21 measuring locations, 5% equals approx. one measuring location (1.05)
italics numbers: satisfactory, equals 5% deviation

Table 3.c: test book, batch 2, first data acquisition

DFG	PAL		Original
0,75	0,68	0,76	Not analyzed
0,91	0,8	0,89	
0,86	0,55	0,91	
0,65	1,02	0,61	
0,75	0,65	0,86	
0,99	0,69	1,06	
0,77	1,39	1,38	

all numbers: 21 measuring locations, 5% equals approx. one measuring location (1.05), satisfactory

Table 3.d: test book, batch 2, second data acquisition

DFG	PAL		Original
0,82	0,54	0,61	Not analyzed
0,81	0,97	0,76	
0,78	***0,24***	0,89	
0,74	0,85	0,64	
0,46	0,89	0,77	
0,85	0,6	0,81	
0,92	1,3	1,15	

all numbers: 21 measuring locations, 5% equals approx. one measuring location (1.05)
italics numbers: 2 measuring locations unsatisfactory, equals 10%, unsatisfactory

Table 3.e: test book, batch 2, first data acquisition

DFG	PAL		Original
0,41	***0,48***	***0,45***	0,86
0,74	***0,44***	1,02	0,73
0,67	***0,48***	0,62	0,56
0,83	***0,33***	1,31	0,5
0,58	0,62	0,89	0,56
1,12	***0,4***	1,14	0,56
1,11	1,15	1,59	0,83

all numbers: 28 measuring locations, 5% equals approx. one measuring location (1.05)
italics numbers: 7 measuring locations unsatisfactory, equals 33%, unsatisfactory

Table 3.f: test book, batch 3, second data acquisition

DFG	PAL		Original
0,42	***0,48***	1,03	Not analyzed
0,66	***0,44***	1,76	
0,56	***0,47***	0,51	
0,85	***0,34***	1,5	
0,59	0,6	0,99	
0,91	***0,42***	***0,45***	
0,73	1,24	1	

all numbers: 21 measuring locations, 5% equals one measuring location (1.05)
italics numbers: 7 measuring locations unsatisfactory, equals 33%, unsatisfactory

table 3.g: Original papers (OR), batch 3

0,85	0,86	***0,45***	0,58
0,88	0,85	0,77	0,61
0,77	0,69	0,75	0,67
0,92	0,86	0,71	0,73
1,1	0,77	0,9	0,78
0,87	0,8	0,98	0,8
1,15	1,1	1,03	0,88

all numbers: 28 measuring locations
italics numbers*:* 1 measuring location unsatisfactory, equals approx. 3.7%, satisfactory

Table 3.h: PAL paper interleaved between original materials

Batch 1	Batch 2	Batch 3
1,15	1,76	0,86
1,13	1,23	1,15
2,12	1,53	1,16
1,64	1,2	1,26
2,04	1,98	1,59
2,05	1,14	1,99
1,97	1,64	2,13

all numbers: 21 measuring locations, 5% equals one measuring location (1.05)
satisfactory

RISK INDICATOR (RI)

The standards for ensuring the quality of treatment differ, depending on whether library- and archives materials are concerned. With library materials, the optical appearance is often more important than for archives. Change experienced by materials does not carry the same significance across different collections. For example, an alteration in the surface gloss of a library binding is less important than the bleeding of printing inks inside a book. Because change is not of equal significance for every treated material, the usual way of calculating the sum of change experienced by materials, expressed as percent, does not provide sufficient information regarding the quality of a treatment. A more complete view of deacidification treatment quality and the risk associated with treatment is gained with the determination of the risk indicator. Risk indicators were first proposed in the context of the DFG project III N2-55722/98 “Criteria for making decisions about the applicability of mass deacidification treatments” (see introduction of this report). Risk indicators can be calculated from three indicator factors (DFG Final Report, vol. II, 2002, pp. 33):

1. Frequency (F) of change experienced by the treated material; it represents the percentage of all recorded alterations of one similar kind
2. Extent (D) or intensity of change; it is numerically expressed according to three levels:
   - Slight – 1
   - moderate – 2
   - Strong – 3
3. An indicator for the level of significance (S) or value of the particular collection; this indicator expresses how significantly any potential alteration of the collection will impede on its value and usability. During the DFG project, three levels of significance were identified while working with the collection of Hessian materials at Marburg University Library (see DFG Final Report, vol. 2). These were also used in the current evaluation (see also Appendix 7).

The multiplication of the three indicator factors produces the risk indicator (RI):

Frequency (F) x Extent (E) x Significance (S) = Risk Indicator (RI) [1]

When individual risk indicators are added up, the total risk indicator can be calculated:

∑ individual results = Total Risk Indicator (TRI) [2]

The higher this number is, the greater and more significant are the changes that are experienced by a collection as a result of treatment. According to the multiplication factors of this formula, the total risk indicator has to result in a number between 0 and 2250.

When objective and universal indicators are applied for the determination of the significance of collections (S), it becomes possible to compare different deacidification treatments with each other.

The test treatments of the materials from the Hessia collection at the Marburg University Library showed that it had a **total risk indicator of 24.51**. This value compares favorably with the **total risk indicator of 21.34** achieved by the papersave swiss process of the Nitrochemie Wimmis AG (NCW). The papersave swiss process is the second generation of the PAPERSAVE® Process. It allows the controlled formation of an alkaline reserve without the need of subjecting the deacidified materials to a re-humidification treatment. This method also significantly reduces the risk of deformation of the treated material. The similar risk indicator numbers of these two closely related treatment methods can be explained by the fact that both of them protect the treated materials from deformation. Deformation was considered a very important factor in the definition of significance level (S) within collections. By comparision, the risk indicator for the PAPERSAVE® Process (ZFB, Leipzig) lies at 46.74, a higher value. Table 4 shows a selection comparative data from the evaluation of the Papersave® ZFB and the papersave swiss process (NCW) (Nitrochemie Wimmis), taken from the DFG Final Report, vol. 2.

Table 4:
Selection of data concerning the changes experienced by artifacts after deacidification treatment; the data reflect the risk indicator for CSC-Booksaver®, Papersave® ZFB, and papersave swiss (NCW).
To establish the risk indicator, 37 books were evaluated.

		CSC-Booksaver®			Papersave® ZFB			Papersave Swiss (NCW)		
Type of change experienced:	S	E	F	RI	E	F	RI	E	F	RI
Accretions on binding	1	0	0	0	0	0	0	0	0	0
Migration of stamp pad inks	1	2,98	1	2,98	1,67	1	1,67	0	0	0
Deformation of binding	2	0	0	0	3,61	1	7,33	1,35	1	2,7
Bleeding of printing inks	3	0	0	0	0,56	3	5,04	0,27	1	0,81
See appendix 7, table 5	---	---			---			---		
Total Risk Indicator		**24,51**			**46,74**			**21,34**		

Significance (S)	Extent (E)	Frequency (F)	Risk indicator (RI)
1: slight 2: moderate 3: strong	0: unchanged 1: slightly changed 2: moderately changed 3: strongly changed	Calculated value 0-10 (% portion/10)	Calculated from S x E x F

Color Stability

To evaluate the color stability of the papers deacidified with Booksaver®, the test papers were subjected to accelerated aging. The aging conditions were static at 80°C and 65%RH, following the DIN/ISO standard 5630:3. All of the samples were pre-conditioned at 23°C and 50%RH, according to DIN/EN standard 18720. Samples were hanging separately suspended during the aging process. Samples were removed at intervals of 8, 16, 24, and 28 days.

The results show that deacidification with CSC-Booksaver® had a positive effect on the color stability of both of the tested papers. Deacidified papers show, in comparision to the untreated ones, a much less intense discoloration. The results correlate with those obtained by Blüher and Vogelsanger who tested the color stability of papers treated with the papersave swiss process, following the same testing protocol (Blüher et al, 2001).

Figure 2: Aging properties of the DFG paper (image taken from paper treated in batch 1).	Treatments are as follows: "Unbehandelt": untreated, aged* "Behandelt": treated with Booksaver®, aged* "Referenz": untreated and unaged * 24 days at 80°C and 65%RH (DIN/ISO 5630:3)

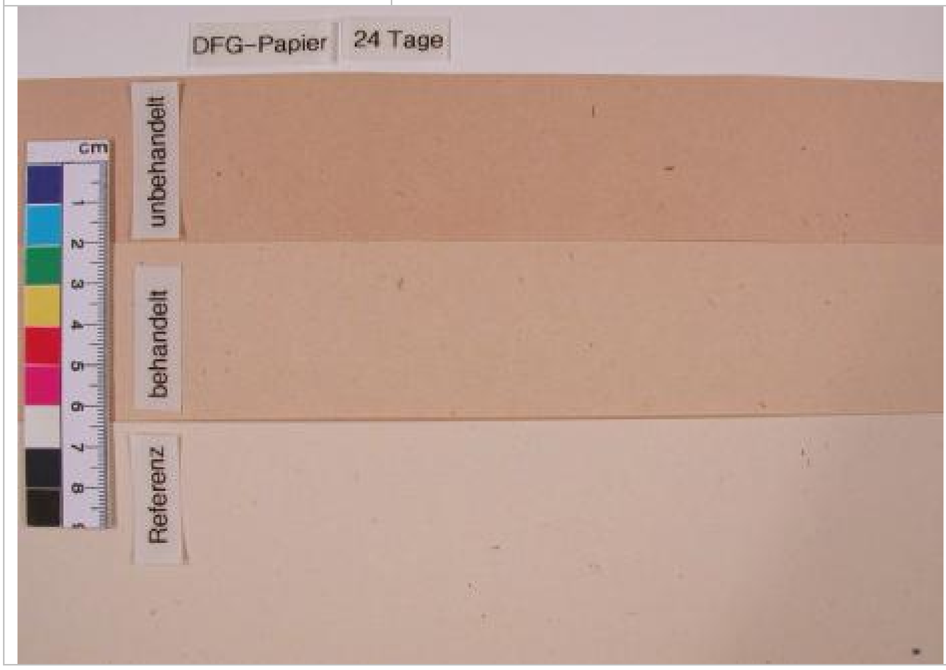


Figure 3: Aging properties of the PAL paper (image taken from paper treated in batch 1).	Treatments are as follows: “Unbehandelt”: untreated, aged* “Behandelt”: treated with Booksaver®, aged* “Referenz”: untreated and unaged * 24 days at 80°C and 65%RH (DIN/ISO 5630:3)

SUMMARY

The CSC-Booksaver® Process is a contemporary liquid-phase deacidification method that involves the introduction of carbonated magnesium propylate via a heptafluoropropane carrier (HFC 227) into the original materials.

Because the deacidification reagent is relatively stable when brought into contact with paper of a typical moisture content, it usually allows the treatment of archives and library materials without an additional pre-drying step. Only particularly sensitive artifacts have to be preconditioned, but only require a mild treatment for about 12 – 24 hours and at maximally 50°C. For deacidification, the materials are inserted into a treatment chamber that holds about 40 kg. The treatment duration lies between 2.5 and 4 hours. Subsequent to the treatment, materials are reconditioned for several days so that the deacidification reagent is converted into a stable alkaline reserve, i.e. into magnesium carbonate or basic magnesium carbonate.

The parameters of the process are adjusted so that the CSC-Booksaver® Process allows a relatively short processing time. The small batch size makes the process easily manageable and controllable. Both of these factors make the treatment overall much safer for the treated materials. Extreme desiccation of the treated material, which causes deformation and accelerates degradation processes, is not required with the CSC-Booksaver® Process, unlike, for example, with the Papersave® Process. The small batch size also allows the operator to prepare individualized batches which reduces the extent and degree of side effects associated with deacidification.

These observations are well supported by the results of testing carried out in cooperation with Marburg University Library which subjected a collection of materials to CSC-Booksaver® deacidification process supplied by PAL. The distribution of the alkaline reserve is inhomogeneous, but falls within the range expected of a liquid phase treatment. In some cases, concerning the treatment of the third batch, the minimum alkaline reserve (0.5%) required was not reached in a few measuring locations. This is most likely due to an irregularity in the processing operations. It was suggested to optimize the process, and to intensify the internal quality control.

On the basis of this research, it can be stated that the CSC-Booksaver® Process is a highly developed and efficient mass deacidification technology that provides a high-quality treatment of the majority of library and archives materials. This research project demonstrated that the results that can be achieved with this CSC-Booksaver® Process are comparable to those achieved by papersave swiss (NCW), which is the most reliable and efficient mass deacidification process in existence today.

The high quality of the deacidification treatment of archives- and library materials achieved by the papersave swiss (NCW) depends on the intensive internal control of the processing procedures. The introduction of similar standards for the quality control of the CSC-Booksaver® Process will further improve the process beyond the excellence it has already achieved at this time.

Prof. Dr. Gerhard Banik

Fellbach, August 7, 2004

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