

Research and Technical Studies–Book and Paper Group Joint Discussion Session 2012: Mass Deacidification Today

ABSTRACT

The Book and Paper Group and the Research and Technical Studies Group presented “Mass Deacidification Today” in a joint session. Moderator Jo Anne Martinez-Kilgore began with a brief introduction to the topic before opening the stage to presenters. Representatives from each of the popular producers of mass-deacidification products were asked to offer their perspectives on the effectiveness of their past and present treatments. To round out the session, two independent presenters were also invited to share their recent research into the risks and effectiveness of popular mass-deacidification processes currently in use in libraries and archives. Following the presentations, an audience question-and-answer period allowed participants to have an open dialogue with presenters about their respective talks.

Representatives of mass-deacidification products included James Burd of Preservation Technologies L.P., Michael Ramin of Nitrochemie, and Dick Smith of Wei T'o Associates. Independent presenters included Fenella France of the Library of Congress and Nora Lockshin of the Smithsonian Institution Archives, in lieu of Anna Friedman of the National Archives and Records Administration, who could not attend.

This open discussion took place on May 11th, 2012, during the 40th AIC Annual Meeting in Albuquerque, New Mexico. The moderator provided panelist introductions and organized a subsequent question-and-answer discussion. Readers are reminded that the moderator does not necessarily endorse all the comments recorded, and every effort was made to record and present the proceedings accurately.

SUMMARY OF PRESENTATIONS

JAMES BURD

BOOKKEEPER DEACIDIFICATION: THE CHEMISTRY BEHIND THE PROCESS

James Burd debuted the new corporate logo for Preservation Technologies, L.P. (PTLP), which is celebrating its 20th year of commercial operation, and introduced a new division for the preservation of film and video. He provided a brief outline of his discussion, which included three main talking points addressing the effectiveness and chemistry of the Bookkeeper deacidification product. He reminded the audience that the Bookkeeper deacidification process is used throughout the world by many large institutions whose thorough vetting processes provide one basis for judging the efficacy and safety of the product.

According to Burd, Bookkeeper is widely used by conservators because it safely alkalizes books and documents. In treating these materials, conservators are primarily concerned with moisture exposure, odor production, and any changes in color or texture of the paper, inks, dyes, or any other materials commonly associated with books and documents. Burd cited early work at the Library of Congress that dealt with the safety of the Bookkeeper system, testing more than 100 different types of paper and books from the 1870s onward. This study reported that the inert fluid used in the process had no visual effect on test samples and created no immediate color changes in paper substrates. The study did, however, find color shifts in samples of blue highlighter and gamboge, as well as a lightening of dark images. Burd reported that this lightening was the result of a heavy application of magnesium oxide, which leaves abundant white particles on the surface of treated papers. He also provided a short list of materials that are known to be incompatible with Bookkeeper chemistry. Of these, he noted which items should remain acidic (e.g., blueprints) and which should be left untreated due to their historically important material composition (e.g., the Declaration of Independence).

Burd reported that there were also no known safety issues with Bookkeeper technology, either to the user or the environment. He noted that the treatment process itself has no odor, is nonflammable, and operates at safe temperatures. The residual magnesium oxide left in the paper of treated items is also nontoxic and therefore safe for handling. He further explained that the process was fully vetted for the Library of Congress by the Environmental Protection Agency and found to be environmentally acceptable and safe for atmospheric ozone. He added that Bookkeeper is a closed system that uses no solvents and has negligible effluence. Burd described how the system naturally filters out some dirt from materials and does require emptying.

The presentation then moved on to the effectiveness of the Bookkeeper system, with a description of the process and ingredients. Burd outlined the components of the system as a fine magnesium oxide powder suspended in an inert fluid. The process deposits a pure alkaline reserve into the substrate of the paper; the electrostatic charge of the liquid attracts the particles to the cellulose fibers. This method allows Bookkeeper to achieve a uniform coating of the alkaline reserve, whose activated particles adsorb and neutralize existing acids.

As part of this discussion, Burd addressed common questions regarding the particles deposited on the paper. Conservators often ask whether particulate systems differ from solvent-based systems, and whether the size of the particles matters. Burd stated that the particles used in the Bookkeeper system are 1 micron in diameter and generally fall between 2–3 microns apart. According to Burd, this coverage is sufficient because the activated magnesium oxide particles have immense internal surface area, giving the deposit of a 1% alkaline reserve five times the surface area of the paper for adsorption of acids.

Burd then discussed the importance of the distribution of the solution with regards to any long-term effects that might be observed. He stated that dipping or evenly spraying the Bookkeeper solution onto collections are the best application methods to achieve a uniform appearance in the treated material. If there is any darkening or yellowing as a result of treatment, these methods will make it uniform across the entirety of the material. He further stated that the acidic components of books and documents migrate through treated objects to the alkaline particles on the surface and are adsorbed, the single most important factor in the effectiveness of the Bookkeeper product. Burd cited studies in which both volatile and nonvolatile acids were shown to migrate between sheets of paper. He stated that all acids—regardless of whether they are treated with a solvent- or a particle-based system, or whether the treatment is applied to the surface alone or penetrates completely through the paper substrate—will migrate and be adsorbed by the alkaline reserve.

Burd then described the methods used to determine the efficacy of the Bookkeeper solution. Standardized sealed-tube accelerated-aging tests, which were developed by the Library of Congress and are preferred by PTLP, produce results that look more like naturally aged paper. Burd briefly described several nonstandard and less vetted tests, which cycle temperature and humidity, before describing the physical characteristics of artificially aged paper samples he had brought. The sample that had not been treated with Bookkeeper before accelerated aging had darkened and was very brittle, while the Bookkeeper-treated sample darkened very little by comparison and retained flexibility. He noted that studies have shown that temperatures used in accelerated-aging tests have little to no effect on the results, especially when it comes to testing alkaline reserve.

In conclusion, Burd noted that 29 years after pioneer Dick Smith first gave presentations on mass deacidification, the same discussions continue. The reason, he stated, is that conservators have not accepted the technology completely. He then questioned whether the conservation community is doing enough, since there is so much material that remains untreated. He suggested that the greatest risk of mass deacidification is doing nothing at all.

James Burd, President And Ceo, Preservation Technologies, L.P.

DR. MICHAEL RAMIN

DURABILITY, QUALITY CONTROL, AND INK-CORROSION
TREATMENT WITH THE PAPERSAVE SWISS MASS-
DEACIDIFICATION PROCESS

Dr. Michael Ramin opened by thanking the audience for inviting him to come and speak about the Papersave Swiss mass deacidification process. He commented on the importance of preserving our cultural heritage and on the particular risks associated with acid decay and ink corrosion in books and archival materials. He noted that mass deacidification provides a cheaper alternative to digitization in ensuring the longevity of research materials.

He began the talk by describing the chemical basis for the solution as magnesium titanium alkoxide dissolved in the nontoxic solvent hexamethyldisiloxane (HDMO). Dr. Ramin commented on the relative safety of the process for both the user and the objects in treatment. He described the practical aspects of the process, indicating that there is no agitation necessary to achieve the desired result, thereby limiting the overall physical risk. Although the treated objects remain stationary, he claimed that the active compound penetrates the paper fully. During drying, the deposited magnesium titanium oxide reacts with water and carbon dioxide to produce magnesium bicarbonate, titanium dioxide, and ethanol.

Dr. Ramin then described the equipment, treatment protocols, and typical batch size for the Papersave Swiss process. Each 800 kg batch of material is placed into a 10,000 L tank of solution. Every treated batch requires a pre-drying step, which is necessary to stave off an early reaction that can cause particles to be left on the paper surface. During the drying stage after treatment, all residual HDMO solvent is removed and the alkaline reserve is built. He noted that most archival documents and dry permeable materials can be treated with this system. He also stated that all of the chemicals are produced by Nitrochemie and are fully recyclable. Dr. Ramin reiterated the importance of Papersave's ability to neutralize acidic decay, though he was careful to point out that it cannot be used to reverse existing deterioration and brittleness.

Moving on to the advantages and durability of a solvent-based process, Dr. Ramin produced a cross-sectional representation of a single sheet of paper with magnesium deposited throughout. He explained that the greater penetration of the solvent-based Papersave Swiss system allows for greater neutralization of acids compared to the particle-based process used by competitors. Treated samples are tested for durability and tensile strength after controlled artificial aging. Such tests, which are conducted all around Europe to compare different mass-deacidification processes, abide by a German standard.

Dr. Ramin then described the quality-control protocols Papersave Swiss uses to ensure successful treatment. For each batch treated by the Papersave Swiss system, the company collects data on alkaline reserve, surface pH, consistency of treatment, and color shifts. He reported that, in addition to these protocols, the company has also retested objects five years after treatment and observed no significant changes. Papersave Swiss is currently planning 10-year tests, along with a plan to compare the data with those collected for similar, untreated items.

Dr. Ramin briefly touched on how Papersave Swiss is used to treat ink corrosion on paper. He stated that the process exposes the objects to no mechanical stress, as it uses organic solvents rather than water, which can swell the cellulose structure of paper. He stated that the iron ions in the ink are immobilized as the acids are neutralized. He claimed that nearly no damage or change is observed in papers after treatment of ink corrosion.

In conclusion, Dr. Ramin reiterated that the Papersave Swiss treatment results in minimal stress to paper objects, with high consistency of penetration in each batch. He reminded the audience that Papersave Swiss puts each of its treatment batches through a rigorous quality-control protocol.

Dr. Michael Ramin, Project Manager Research/Analytics, Nitrochemie

DR. RICHARD D. SMITH

WEI T'O PAPERGUARD: COMPREHENSIVELY DEACIDIFYING,
STABILIZING, AND STRENGTHENING PAPER

Dr. Smith began by introducing Wei T'o Associates and his main objective in founding the company: to develop a one-time, comprehensive mass-deacidification process. Although the Wei T'o system was initially a single-function deacidifying process, it has been developed further to protect against fungus, insects, and oxidative attack as well. He noted that Wei T'o PaperGuard may also be used to strengthen weak paper and to minimize disaster-related damage. The system itself can also be transformed into a disaster-recovery system if needed.

Dr. Smith has been dedicated to the invention of a comprehensive preservation treatment for paper since 1969, when he first determined that paper permanence would require more than mass deacidification alone. In 1972, he received his first Canadian patent for the preservation treatment of cellulosic materials. The Wei T'o pilot plant, built for Public Archives and the National Library of Canada, was initially designed to test and develop mass-deacidification treatments for a short period before being rebuilt to protect books more fully against aging. The plant, which operated from 1981 to 2002, proved to be so successful at mass deacidification that it was never rebuilt to deliver a more comprehensive treatment. However, according to Dr. Smith, the early pilot plant process had many limitations. Although the first Wei T'o system was perfectly safe for use and won awards for its environmentally safe application, the early deacidification solutions had short storage lives, were somewhat unstable, did not strengthen paper, and did not protect against biological or oxidative attack. Dr. Smith developed PaperGuard to address these limitations.

The first step of the nonaqueous PaperGuard system is vacuum drying of the objects to be treated, followed by forced penetration of a liquified hydrocarbon gas solvent containing aluminum-, magnesium-, titanium-, or zinc-based organometallic alkoxides as deacidifying and biostatic agents. The excess solution is then removed, and the biostatic alkaline reserve is deposited. Vacuum and air-conditioning processes then recover any residual solvent through condensation, and the components of the solution are recycled. Drying is followed by a strengthening phase that stabilizes the paper by catalyzing free-radical reactions between ethylene gas monomers and weakened and unstable cellulose. Finally, the treated books and documents are reconditioned to normal environmental conditions before being returned for reader use. Dr. Smith claims that the system is "environmentally sustainable, emits no contaminants, and deposits only stable, safe residues" (Smith 2012, 2). It also takes advantage of advances in chemical engineering, combining single- and double-metal alkoxide treatments for improved

deacidification, the stabilization of chemical residues from papermaking, and strengthening of weakened or brittle paper.

According to Dr. Smith, PaperGuard has the unique ability to customize treatment for a wide range of materials and applications. He added that its sterilization and vacuum freeze-drying components allow PaperGuard to be converted into a full-spectrum disaster-recovery system. He noted that the PaperGuard system can recover up to 99.5% of solvents, eliminate treatment defects, lower maintenance costs, and increase operational safety and reliability. However, Wei T'o Associates requires business partners to implement the PaperGuard system and make it available worldwide.

Dr. Smith's presentation was cut short due to time constraints, but he provided a handout and flowchart describing both the PaperGuard system and a new, high-RH, "dry" aqueous mass-deacidification system for rare and valuable books and works of art on paper. This handout (Smith 2012) was used to provide a transcript of his entire talk.

Dr. Richard D. Smith, Owner, Wei T'o Associates

JEANNE DREWES AND DR. FENELLA FRANCE
TAKING THE MEASURE: TREATMENT AND TESTING IN MASS
DEACIDIFICATION

Dr. Fenella France first described the acidic collections of the Library of Congress, which cover more than 150 years of history and continue to grow yearly. The library's mass-deacidification program was started by Ken Harris, who headed the program until his retirement in 2011. It now operates under Jeanne Drewes, who was unable to attend the session.

The Library of Congress's interest in mass-deacidification processes began in the 1970s. In the 1990s, the library began to further scrutinize the use of diethyl zinc (DEZ), identifying process-related problems with the system and finding ways to eliminate them. Library staff also began to examine the Bookkeeper process, as well as other technologies, in order to determine which had the best potential to meet Library of Congress standards for deacidification. In 1996, it was determined that the Bookkeeper process met these requirements.

The Library of Congress has rigorously tested all of its deacidification treatment batches with test books and papers, and library staff continue to work closely with Preservation Technologies, L.P. (PTLP) to ensure that the same standards are met for alkaline reserve and longevity of material. In general, the Library of Congress attempts to raise the pH to 6.8–10.4, and deposits a 1.5% alkaline reserve. Dr. France commented that the partnership between the library and PTLP allows for quality control and standardized testing of the process. She added that these safeguards further ensure successful and safe treatment.

Dr. France then outlined the Library of Congress's 35-year deacidification plan, which calls for treating 250,000 books and 1 million individual manuscript sheets per year. As of 2010, the library has treated 3 million books and 8 million individual sheets. She briefly described the selection process and reiterated that acidic collections are still being acquired by the library. She commented on the common misconception that acidic materials are generally older in manufacture; acidic materials are still generated around the world. Even now, she said, 20–40% of Indian publications and 2–3% of papers from the United States require deacidification, since publishers source papers from outside the United States.

Dr. France encouraged the audience to use and download the digital resources available on the Library of Congress website. She noted that an annotated bibliography of published mass-deacidification research was prepared as a basis for assessing consistency among research programs around the globe. In 2011, the Library of Congress attempted to compare research data in order to draw conclusions about available mass-deacidification processes, but no useful comparisons could be made due to inconsistent research methods. However, Library of Congress scientists were able to identify some areas that are normally overlooked: the internal structures of books, for instance, are rarely tested consistently.

When testing the results of mass deacidification, Dr. France challenged researchers to ask the right questions: Can we be sure treatment penetrates the spines of books? Does accelerated aging mimic real-life conditions? What approach is most cost effective? Dr. France noted the difference between focusing on immediate change and the long-term effects of treatment and emphasized that the usability and longevity of collection materials over a significant period of time is most important. She also questioned whether researchers are adequately testing cost-effectiveness, given the limited resources in our economic climate.

Dr. France reiterated how difficult it is to gain an accurate measure of the different deacidification processes based on existing research. She noted that different units are used around the world, different components and effects are tested, and accelerated-aging protocols vary. In testing paper strength, for example, different researchers used different methods (e.g., tensile, folding, or tear-strength tests) with different units of measurement on different materials (e.g., books, papers, or surrogate papers). Dr. France went on to discuss a wide range of questions generated by the comparison of existing studies and suggested how some of these issues might be addressed in future research. She suggested that researchers could gain more informative results by redefining which information is important.

Dr. France then revisited the idea of cost effectiveness and described how the Library of Congress attempts to balance mass deacidification, digitization, and environmental control to maximize care of and access to its collections. She suggested that testing parameters for mass deacidification should

be standardized across the board for all the various processes, and that testing should be conducted by independent researchers, not manufacturers or vendors. Then, she added, conservators will have solid data to support the best means of caring for the world's collections.

Jeanne Drewes, Chief and Program Manager, Binding & Collections Care/Mass Deacidification Program, and Dr. Fenella France, Chief, Preservation of Research and Testing Division, Library of Congress

ANNA FRIEDMAN, PRESENTED BY NORA LOCKSHIN

EVALUATING DEACIDIFICATION AFTER 20 YEARS OF NATURAL AGING

Nora Lockshin began by acknowledging Anna Friedman, who was awarded the Smithsonian Institution Post-Graduate Fellowship in Conservation to study the effects of natural aging on architectural drawings that had been deacidified between 1989 and 1991. The material reviewed for this project originated from Smithsonian Institution Archives Record Unit 92, and was comprised of drawings and prints dating from 1880 onward, mainly depicting Smithsonian buildings. Prior to the establishment of the current preservation unit at the archives, archivists selected objects from this collection and sent them to the Northeast Document Conservation Center (NEDCC) for treatment. Lockshin noted that the selection criteria for these items were unknown, but the documentation shows that slightly fewer than 100 of the treated items were deacidified, either by immersion in an aqueous magnesium bicarbonate bath or with Wei T'o Soft Spray.

Lockshin then offered some historical perspective on the treatment documentation, providing an image of one of the old documentation forms and noting the differences between what was considered appropriate then and what conservators might prefer today. She commented that the earlier records were missing important rationale and treatment notes that are often included as part of current practice.

Lockshin then described the extensive architectural drawings database (ADDS) that was used to select the sample sets for this project. She explained that Friedman had chosen her two treated sample sets based on whether items were treated with Wei T'o Soft Spray or immersed in a magnesium bicarbonate solution, eliminating items that had no explicit record of deacidification treatment either way. Friedman also eliminated items that might have been washed as a deacidifying step prior to non-aqueous alkalization. The ADDS was also used to choose the control sets, which featured untreated items from the collection that were similar in date and fabrication to those in the treated sample sets.

The drawings were subjected to both qualitative and quantitative observations that were explained in detail during the talk. The bulk of the quantitative data consisted of surface pH

and colorimeter readings. Qualitative data included physical observations made by the researcher to determine whether any other treatment-associated problems existed. Lockshin noted that, in some cases, data collected during tests did not support the treatment documentation. She gave an example in which the pH of the recto of an object was rather low, while the pH of the verso was quite high, indicating that the object had only been treated on one side.

Lockshin used graphs to explain how the quantitative data from the sample group was compared to data from the control group to identify any trends. A pH range of 4.5–5.5 was observed for the untreated controls, while a slightly higher pH range of 4.5–10 was observed for the sample items treated with magnesium bicarbonate (most measured in the range of 6.5–8.5). The Wei T'o-treated samples produced the greatest pH range, with the lowest pH readings appearing in items that had only been sprayed on one side. Friedman found that tracing cloth impregnated with starch was the support most resistant to deacidification. Lockshin reported that in a few cases objects from the control group yielded pH readings greater than 10, suggesting that their treatment records are lost or incomplete.

The qualitative data also revealed an interesting phenomenon. In visually examining the drawings, the researchers were particularly curious to see whether any visual effects resulted from either the Wei T'o Soft Spray or the magnesium bicarbonate bath. Lockshin described how some differences were observed on the treated sides of items under long-wave UV radiation, indicating that Wei T'o spray affected the fluorescence of the item. She provided minimally processed digital photos of both the recto and verso of one such treated object to illustrate what was observed during examination. A fluorescent pattern indicating areas of higher saturation—including finger marks, which may have concentrated the absorption of the treatment solution—was notable under UV light. The grid pattern where the pH measurements had been taken was visible as a quenching of the fluorescence.

Friedman's findings were consistent with other existing research. Her data supported the results of other artificial-aging studies and further illustrated that, after 20 years of natural aging, treated items for the most part remain less acidic than untreated items. In particular, Friedman's work demonstrated that aqueous treatment by immersion in a magnesium bicarbonate solution provides more consistent results than nonaqueous spray. Friedman also used her results to perform a cost-benefit analysis of deacidification options and to develop a decision tree for use by repositories as they consider treatment protocols for similar items.

Anna Friedman, Conservator, National Archives and Records Administration (NARA); Presented by Nora Lockshin, Paper Conservator, Smithsonian Institution Archives

MASS DEACIDIFICATION TODAY: DISCUSSION SESSION

Moderator: Are the available solutions appropriate and effective for single-item, nonaqueous treatment of individual documents or books with acidic ink? Which processes are available commercially for single-item treatment?

Dr. Ramin: With the Papersave Swiss treatment it is not possible, because [single items] react too fast with water.

Moderator: So it is only a mass-deacidification process?

Dr. Ramin: Yes.

Moderator: Dr. Smith, your PaperGuard process will also only be a mass-treatment process?

Dr. Smith: Yes, I spent all this time developing a treatment that is really comprehensive. It would do all kinds of mass and sizes of books and newspapers. Single sheets, though, [could be treated] by spraying, dipping, or immersion. There is a whole host of equipment that is being developed for odd kinds of things like wallpaper, [equipment] you could carry like a backpack. There is nothing by comparison that is universal in its potential, including the possibility of combining single-alkoxide and double-alkoxide solution systems.

Audience Member: I have a question for Jim [Burd], coming from the perspective of an end user. I have checked out a lot of new fiction books from the Library of Congress that have been treated with Bookkeeper, and I notice that as I am reading there is a gritty particulate texture, so much so that I feel like I need to wash my hands afterwards. Can you comment on that?

Burd: Sure. The Bookkeeper process depends on how much material is deposited onto the paper and the weave, the openness of the paper. Usually any sensation that comes from touching the paper is more of a drying of your hands than a coating of your hands. The particles are very absorbent and will absorb the water and moisture from your skin. Normally that goes away, so I don't know the age at which the material was treated, but as it absorbs water and ages over time it usually goes away. Some of the earlier material we treated was more heavily treated, and since then we have made changes with the process. So it is possible that it was older material. In most cases, you should not tell the difference [after treatment]. We do not expect people to know that it's been treated; it is our goal that you cannot tell.

Dr. France: I just wanted to follow up on that. On some earlier materials we were still developing the lower micron size for

dispersion, so I would suppose it was from that earlier time period. I would be interested to know the particular details. We could take those items and test them. So if you can contact me, I would be really interested.

Burd: Can I comment real quickly on the ink that you mentioned earlier? For those who missed the talk by Season Tse from CCI, deacidification of ink is quite effective on acidic inks. It was quite a nice report and would be good to look at. For those of you who do not stay abreast of Europe so much, there is a terrific project called InkCor there;¹ they took a look at principally iron-gall inks, but there are a lot of other acidic inks. Deacidification by itself is not the solution for those, although there is normally a significant improvement just with deacidification, whether it is Bookkeeper or any other deacidification process.

Lockshin: I would like to respectfully disagree, until we look at Season's published paper. What I took away from that presentation is that the tensile strength of paper was increased universally, but a lot of things do remain acidic if there is not a chelating process involved. So the chemistry of inks still can be separate from the paper. It's great that the tensile strengths are increased overall, but I would look to her paper.

Audience Member: The Italians and a lot of people still say that the Bookkeeper process changes the feel of paper—not only the grittiness, but makes it feel like a different substance altogether, like plastic. They have given papers at the American Chemical Society I have been asked to address that issue in the past, and I was just wondering if James Burd can address that issue in some sort of systematic way, other than saying that the process ... used to be less consistent in the past and is better now. So do they have plans for dealing with that question ... ?

Burd: Sure. When we talked with the conservators in Italy in the past, first of all, Italy's focused on water washing and rather opposed to looking unilaterally at nonaqueous deacidification. So there is tremendous interest there in furthering aqueous deacidification. So, I am not familiar exactly with the talk that they gave at the ACS. I will say that we have lots of customers in this room. To some extent, it's up to the individuals to determine whether they can tell the difference. I can tell you that in normal situations, with books that come out of our treatments, it is very difficult to tell it's been treated. I can't dispute if someone says that they can feel it. Perhaps that's true and perhaps it depends on how the particular material is treated, but it is possible. If you spray documents—and you can do so today if you like, I have some spray—it will be impossible for you know that it's done. So, I can't tell if it's an issue of quality control. I don't know the answer to that, sorry.

Audience Member: I was thinking not aqueous versus your organic solvents, ... just the organic solvent treatments I was wondering if there was any other sort of response to that [question] other than ... quality control by Bookkeeper ... ?

Dr. France: Just wanted to note, though I know it doesn't actually answer the question: We have 20 years of test papers and test books. ... I have now located all of those and [will] be starting to go through those [to] start to more effectively address that question. So I will be looking at some of the earlier papers, at the slightly earlier treatments, and adding up that qualitative component as well.

Audience Member: I don't think preservation is the issue, but ... also appearance, and I think they got that down, but this is kind of an unanswered question.

Dr. Smith: I would like to maybe comment first. There have been a lot of questions about different kinds of particles and chemicals used in deacidification. Some scientists and conservators have been concerned about particle size in treatments, and I noticed that in Jim's talk today that he was recommending the TAPPI-544 test [aging of paper and board with moist heat]. TAPPI stands for the Technical Association of the Pulp and Paper Institute; they are the organization, plus one or two others, who establish methods. TAPPI's latest specifications, or most recent, have mentioned that particular method [T544] should not be used for evaluating permanent papers, or the permanence of papers. I would suggest that it's worthwhile running a test. ... In 1995 The Pulp and Paper Institute of Canada recommended a patented method of doing book deacidification where papers were interleaved with alkaline paper [and humidified]. That method used about one-fourth as much water as the TAPPI method does. My question is whether or not a deacidification treatment might be occurring [during moist-heat aging in papers treated with alkaline particles] before the aging occurs? It's pretty simple to check that. I would suggest that it may be worthwhile [for] somebody [to do] a study on that. I would also propose doing, say, an overnight [TAPPI-544] test [on particle-treated materials] using 50% RH & 90 degrees centigrade ... and then simply run a test dry-aging with very little moisture, and see how they compare. That is kind of where the controversy exists, and ... my concern is simply, are we measuring what we think we are measuring? And is the test absolutely applicable? It just doesn't seem to me that somebody can use so much less water and get an increase in permanence, and use more water and find that there is not going to be a deacidification treatment occurring

Audience Member: A question of terminology for Jim Burd and a slightly more substantive question for Dick Smith. My

first question is that you mentioned the term "pure alkaline reserve." What do you mean by pure alkaline reserve?

Burd: Well, I guess what I mean to say is, first of all, that [what] we are putting in the paper in terms of the magnesium oxide is very high-purity material. Really, what I meant by that was, we are not putting any solvents in; we are not putting any other ingredients other than magnesium oxide into the paper. When you get your paper and books back, what you get is magnesium oxide. You won't have any other chemistry in it at all because everything else is fully recovered.

Audience Member: OK, that clarifies it completely. The question for Dick Smith is, you mentioned very briefly that you're developing methods to optimize the pH, to select specific pH for material. You said it was [for] artists' materials, [so] I would assume you're not doing that as a part of mass treatment—that would be more of an item-by-item treatment. The question would be ... , what is your approach to getting a specific pH when you deacidify?

Dick Smith: I'm not sure I understand the question. Was the question how might one get to be able to establish treatment solutions that produce different pH values in the treated paper?

Audience Member: You were proposing this as a solution for various artists' materials, that you were interested in optimizing pH for this reason. Did I understand that correctly?

Dr. Smith: Yes, I don't know if there is a specific pH for artists' materials because they use different materials. What I am thinking is that with this use of double alkoxides—which you can make ... soluble in non-aqueous solvents and combine ... with single alkoxides—you would be able to produce, I think, even acidic pH values, neutral pH values, or very much a range of pH values. Then, my question is whether or not we should be using more zinc, which would protect against bio-attack, fungus, and that kind of thing permanently. Also, that would handle most of the different art-type problems, simply using a zinc- or zinc-aluminum type double alkoxide. At the time when I started on single alkoxides, this kind of chemistry was not available. It's progressed into doing wonderful things. There's been enormous change over the years in the kinds of chemicals and materials that are available, both in their variety and their purity. I lived through this change. When I went through school, as a little background, we used things that came out of the mine, and they varied. Nowadays, you can buy purified materials and so forth to a large extent. But the kinds of things we are talking about take highly purified materials. Chemists have learned since to build molecules with very special properties. These chemicals are expensive, but the quantities that are necessary for deacidification, and

the benefits which they give, make them cost affordable. By combining the double alkoxides, which are highly soluble, with single alkoxides that are not so soluble, you can get the beneficial properties from both kinds of treatments.

Audience Member: That does answer the question, and it sounds like the compounds that you are depositing—you may have not identified them, or are not vocalizing them exactly. But they will optimize pH and potentially do other things to those materials to restore health. So that does answer my question.

Audience Member: I am curious to hear a little bit more about how the inks benefit from deacidification using the Bookkeeper system. You mentioned this in your comments, and I was curious about the chemistry behind this. How was it measured? Especially those inks that are manufactured using acidic technology [that] are supposed to stay acidic. I would like to hear more about it. My second question: Is there a certain quantity of materials that darken or yellow in reaction to the Bookkeeper system? If so, I'm curious if the ratio of materials which react this way has been measured.

Burd: First of all, acidic inks. In most cases, if you have ink that you want to be acidic and need to stay acidic—because of color, or you may lose information—clearly that's not something you want to deacidify. But if you have an acidic ink like iron-gall ink, then we want to stabilize the iron-gall. You can't just do that with deacidification. Then, we need phytate solution or something along those lines. In conjunction with that, we need to protect the substrate and stabilize those inks. We don't want to convert them necessarily to alkaline inks, but we want to stabilize the substrate and therefore protect it from further ink corrosion.

Audience Member: So you are saying you would exclude those materials that may possibly contain those types of inks?

James Burd: Well, we don't exclude iron-gall ink—certainly it benefits, that kind of ink benefits. We need to make a distinction between inks and pH-sensitive colors. The real issue is, do we want to allow color change or would we lose information with a color change? In that case, you certainly don't want to deacidify, but an acidic ink like iron-gall ink can be put through the process, although that is not the whole solution for iron-gall ink.

Dr. Ramin: For the iron-gall inks, if ... it's possible to treat them in a nonaqueous solution and you don't have to add any mechanical stress, then you have no damage of the manuscripts. If you don't want to lose the information, and you can live with a slight color change, then this is maybe better than to lose the manuscripts. You have to think about, is it the most important thing to change nothing in the original and

wait until it is brittle and [has] lost information, or can you live with a small change of the color?

Audience Member: OK, thank you. That is what I was hoping to hear; I just thought that maybe there was something else missing.

Dr. Smith: I ... have a little thought: Here is a concern about yellowing in the paper from treatments. My original reaction—a long time ago, when Wei T'o was criticized because the paper yellowed—was that [the yellowing] was a measure of how good the penetration was. It was absolutely down to the molecular level, and I still raise the possibility that that exists. I believe that one of our evaluation techniques should be how [treated items] are going to look about 100, 500, or even 1000 years [after treatment]. ... Are these discoloration consequences that Michael mentions worthwhile because you sacrifice a little to gain centuries?

Burd: To address the yellowing of Bookkeeper: First of all, in solvent-based processes, it's a much more complicated chemistry with the treatment. You have alkoxides that are reacting immediately with some materials, you have alcohols that are formed and [that] can react with some materials, so it is very different kind of reaction, but in general you will see a darkening very quickly with those processes—not unlike what you will end up with anyway, with natural aging. In the case of Bookkeeper, those other complex reactions do not occur because none of that chemistry is there in the first place. That is why when you first spray it there is no immediate change to be seen. In many cases, if you do CIE L*a*b* readings and look for yellowing, you don't see that—but you can in some cases. My comment in terms of yellowing is simple: Because there [are] different yellowing effects once you spray Bookkeeper on, then you want to have a uniform coating, so that however it ages, it looks relatively uniform.

Audience Member: Did you have a chance to conduct any kind of analysis of ... the percentage of the materials that darken versus those that don't darken?

Burd: Well, to some extent the problem is [that] you have to do accelerated aging to see the darkening. There's really almost never any prompt darkening of materials. So unless you have an extended period of time—and, really, 20 years is hardly anything in these cases—you can only really address [the question through] accelerated-aging of materials, and that makes it a little difficult.

Dr. Ramin: We measure the color changes after each batch, and normally, for lignin-free paper, the delta E value is about 1, so you can measure it but you cannot see it. And for ground wood or newspaper there would [be] delta E between 2 and

3, so you see it, but if you wait some years, the untreated paper is much darker or yellower than the treated paper.

Audience Member: My question is about Wei T'o. It was mentioned that it protects against microorganisms, and I am curious to hear a little more about the chemical process. Through what part of the process does this happen?

Dr. Smith: The Wei T'o process traditionally does not [protect against microorganisms]. The kind of chemistry [that] the Library of Congress developed is a diethyl zinc treatment where the zinc is the deacidification agent. They have definitely proved it is a good deacidification agent. They recognize in some of the literature that they didn't push it, but that it was an acceptable biocide. I know of one academic study in Poland where a master's or PhD student compared zinc oxide or zinc carbonate impregnated in the paper, against the best known—in his opinion—chemical ... that had a very high standard result in protecting against fungus—and, I believe, insects, though most of his tests were with fungus. The results simply showed that zinc did a better job, and I think we can put that into an agent and use it. If you look at your medicine shelf and look at the various kinds of chemicals that you use, particularly on your skin, you will find zinc in almost all of them. You may not know this, but small quantities of zinc are put into roofing felts—you know, for roofs of houses—in ... urinals, all kinds of places like this, to prevent fungus and other kinds of things. ... There is no way that paper is going to come into that kind of treatment, you know, as we handle it. I just cite that it's effective and there is no reason we can't use it.

Dr. Ramin: Also a comment for mold: We look at paper with mold damage. We have two days of vacuum; we kill the mold. With the treatment we change the pH of the paper, and mold already in the paper likes to taste acid paper. ... After treatment, we have alkaline paper; this kind of mold doesn't like the paper any more. We kill the living mold on the paper, and normally after treatment the paper is under ideal storage conditions, so I don't think you need any further substance in the paper to avoid the mold.

Burd: There have been a couple of studies in the U.S., in fact, about mold [and] Bookkeeper deacidification. They show that the process seems to be a good improvement of mold prevention.

Dr. Smith: There is one negative aspect of zinc as a possibility: that certain types of it can be changed by light, which is why it was used in a photocopy method. It was effective, but it was temporary. It darkened the paper. I don't think it's going to occur in treatment, but it was simply something that

in our evaluations we have double-checked to make sure it doesn't happen.

Audience Member: I am personally interested in hearing about studying the natural aging of papers treated with any of these processes. I would like to encourage institutions that have done this in small or large scale to try and do what Nora presented and do studies of the natural-aging characteristics. So my questions: For Fenella, I understand ... that you are now nearing about 10 years of data for collections that you have treated with the Bookkeeper process. Are you undertaking any studies of the natural-aging characteristics of those collections? For Nora, I was curious ... whether there was any data available on post-treatment storage of treated collections, and whether the treated collections were stored differently than those that you used as controls?

Dr. France: Thank you very much. Due to the time frame [of the talk] I didn't have time to go into it. And also because of budget cuts we are low on staff at the Library [of Congress] at the moment. But we are initiating a long-term study of the papers we have. We have papers back from the first testing in the 1990s from all of the different tests. The first thing we had to do is actually decide how to select from that, because there is just no way we could test all of them. Plus, we have the test books, which I mentioned, we have both the single sheets and the test books to actually see long term what's happening with the natural aging. We'll be initiating that study, hopefully within the next six months. So, please get in contact with me.

Lockshin: Thank you for that question, because it does get to address something that I was unable to discuss because of time. One thing I can say, that is really a great thing for most of the materials that were treated by NEDCC, is that almost every object—at least according to the documentation that we have, and the physical reality of what we have in our collections—is that almost every object that was treated with a deacidification and alkalization protocol was rehoused in a sealed Mylar encapsulation on all sides. We opened these to access them for the research. In some cases, one or two may have already been opened. With the exception of those outliers in the control group that were measuring in the 9–10 [pH] range—perhaps those had been unsealed by some of our prior colleagues, I don't know—or perhaps they were missed in terms of sealing, or were not desired to be encapsulated. For the most part, given the pH data that was pulled off of the fronts and backs of those drawings, we were very pleased to have an encapsulation that could otherwise be looked at as an interleaving layer.

Audience Member: May I follow up? Were the controls also encapsulated, untreated, or were the controls left as they were?

Lockshin: You know, I would have to go back to Anna for that. We did rehouse all of the materials that had been previously encapsulated, right back in; we simply didn't seal the weld that we slit open. So the ones that were reported as having been treated, I believe Anna did create some new encapsulations for them.

Audience Member: Before you went to testing and you chose the controls, were the controls also encapsulated, even though they were not treated?

Lockshin: Not necessarily.

Audience Member: No. So the controls were left as they were, in folders or ... ?

Lockshin: Probably. What happens here is about 500 drawings went to NEDCC. How they were selected, we're not sure—probably the value of the image and [its] appropriateness to the mission [and] history of the Smithsonian. Some were chosen for mending, you know, not everything went for deacidification treatment. The controls included items that were sent and [were] picked by fabrication style, not necessarily because they were the same treatment. They were actually picked because they didn't necessarily have a deacidification treatment. ... If I go back to the paperwork, I would assume those controls did not have encapsulations on them.

Post-conference clarification from Anna Friedman: All of the documents treated by NEDCC that I tested as part of my test groups (for both types of deacidification) were cut out of their encapsulations at the time of testing, then replaced in those same Mylar enclosures, as L-sleeves, when returned to the stacks. The control drawings were selected to be of similar fabrication and similar age to the test items, with no record of their ever having been treated. None of the control drawings had been encapsulated. They were deliberately selected from drawings in Records Unit 92 not sent to NEDCC to reduce the possibility they'd been treated. They were just in folders in the stacks.

Audience Member: I have a comment, then a question. This is an audience of people who know a lot about the complexity of paper, the complexity of mediums on paper, and we can make judgments about what we think are suitable materials to be deacidified, no matter how that is actually done. What I find really disturbing is the literature, the ads, the conservation supply catalogs, and trade show exhibitions, where perhaps unsophisticated audiences get the impression that deacidification should be done as a blanket treatment—that if you don't do these things, you are not going to have a collection that is going to last very long. I would request the vendors to kind of tone the rhetoric down and emphasize

not only the benefits that their various processes can do, but also emphasize that the selection of materials has to be done extremely carefully—that these are never to be considered as blanket approaches, even [though they] are being sold as mass-deacidification processes. ...

My other statement, which is going to lead to a question, is [that] most of the brittle materials that we deal with—that are extremely brittle to the point of objects being unusable—usually consist of alum-rosin-sized ground-wood papers that contain a great deal of lignin. It has been reported within the last few years that if you increase the pH of the papers containing large amounts of lignin, that you actually destabilize the lignin, that it itself is more stable at pH 4 or around there. I am wondering if anybody has actually looked into the role that deacidification at very [high] pH [plays], or [does it] have an effect on the destabilization of these papers?

Lockshin: If there had been no other mention—if we had a little open time—I was going to bring this conversation back around to the theme of outreach. In my very public position at the Smithsonian Institution, we receive calls constantly about use of some magic ingredient, some silver bullet, that someone can spray on their object to preserve it and save it. So those questions sometimes speak directly to a product that they've seen curiously in a magazine, or a catalog, some newspaper report, or another one of the catalogs that is out there. Now with the Web, it is so much easier to find these options, including Bookkeeper and Archival Mist, and the preservation "save your genealogy" work kits that are out there. So, with that background in mind, I have to say, an outcome of our research—which is very notably small scale, I mean, I am surprised and pleased that we were included in this mass deacidification talk—essentially, we are talking about single-item treatment. But if we extrapolate the single to the hundreds, certainly dozens of calls I receive directly—hundreds that are out there and thousands who are potentially looking at websites, at the Library of Congress, National Archives, and Smithsonian Institution for guidance—we have to extrapolate that this is a mass treatment with spray products available on the consumer market. I have to say, the products used in our research do not make me feel comfortable recommending their use by the regular consumer without the proper selection factors in mind. We always advocate looking for a conservator first, asking whether treatment is really necessary and if that is in fact the goal of the person's use of that object. We highly recommend preventative conservation whenever we can as the biggest bang for the buck, and the safest option is going to a conservator. For smaller archives and libraries that can't afford to have a conservator on board and want to do something, we still advocate preventative conservation.

Moderator: We still need to address the lignin question before we move on to other questions.

Burd: I am delighted to hear you are having thousands of consumers ask about stuff, because they are not flocking to products like that. There are a couple quick issues regarding lignin and whether our products attack and destabilize lignin—that has been reported to some extent in literature. I can't speak definitively on those issues except to say that the least useful thing to deacidify is something that is so fragile you really can't handle it. We don't strengthen the paper, so from a selection criteria, the last thing we would recommend is that you deacidify something like that. Not because we are worried about the lignin, certainly, but simply because it's not a good value in treating the material. So I can't tell you that it is going to make it weaker faster at that point, or rather tend to slow it down, continue to slow it down—it already has very little structural strength left.

Secondly, about outreach in terms of vendors, really, there [are] not enough people doing deacidification these days, and certainly not to the extent that they need to. Companies like Creative Memories that come along and tell people to throw away their newspaper clippings because they are acidic are not doing a service. So we came out with a product called Archival Mist, but Bookkeeper and Wei T'o have been on the market a long time. The issue there is simple: People have materials to treat—they have newspaper clippings and old letters and different things. They are not going to get conservators: The best they are going to do is stick their stuff in a shoe box in improper conditions. It would be much better for them to spray it. We are not talking historical value, we are talking about family value. We don't try to mislead anybody with our product, and for the most part, it is perfectly safe to spray your newspaper clippings. So we don't really feel bad about that. What I feel bad about is that most people don't do it. Most people do not preserve their family artifacts instead of just throwing them away.

Dr. France: I just wanted to make a very quick comment. One of the things I consider a huge part of my role is educating administration about the role of preventative conservation and how we need to care—in terms of the code of ethics—for reversibility of anything we recommend. So thank you.

Audience Member: We just started a project on mass deacidification with Bookkeeper. When [Jim Burd] said, "Not doing anything's the greatest risk," I'm not sure if I agree, because the handling that is involved with Bookkeeper is extreme. I would like to point this out as a comment. I was also wondering if there is any plan on finding out better handling techniques, like [in] the Papersave Swiss process? I also want to go back to the white deposit. We had an extremely high amount of white deposits. That brings me to the question, does Bookkeeper appear in the core of the paper as much as it appears on the outside, on the surface?

Burd: About the handling of books: First of all, we have to open the books because you have to be able to get the particles to the structure of the paper. We have to be able to open them and immerse them in our solution. You can't do this in a closed option. You have to use a solvent-based process if you don't want to open the books at all. The advantage of Bookkeeper is that there are no solvents, and the disadvantage is that you have to handle [the materials]. In most cases, people aren't going to send us materials that can't be handled. If there is material that needs to be handled differently, we can address that issue, certainly. In terms of extreme handling, you need to ship it to us. We open it carefully and put it on a holder, treat it, and put it back. It is very neutrally buoyant and very low stress, but you do have to handle the paper. In terms of white material on the surface of the paper, it is distressing to hear you feel you have a lot of material on the surface of your paper. I'll be sure to address this issue. I would say that is not a typical response. I would not expect to hear that. As for your question of whether the Bookkeeper particles are in the paper as much as they are on the surface of the paper, as I mentioned in my talk, it completely depends on the porosity of the paper. It is not essential that it is through the structure of the paper to do what it needs to do.

Audience Member: Our program is called Heritage Science for Conservation, and I'm pleased to announce that we are done with our data gathering. We still have some data workup on a project that is headed by book conservator William Minter on polyester film encapsulation. We have—and I think this has been a big question in this community—seen some effects after 22 weeks of aging on the questions of whether or not to deacidify, the importance of deacidifying prior to encapsulation. We are going to be writing those up in the coming months and hopefully that will add to this discussion as well.

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NOTES

1. For more information on the InkCor project, see <http://ink-corrosion.org/>.

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