Case Study

Mass Deacidification: Universal Cure or Limited Solution?

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Abstract: This article is a modified version of a paper presented at the 1992 annual meeting of the National Association of Government Archives and Records Administrators held in Washington on 15–18 July 1992. The author expresses special thanks to Ellen Desmarais, director of the Conservation Treatment Division, Archives Preservation Branch at the National Archives of Canada, for her contribution. Responsible for the management and operations of the Mass Deacidification System of the National Archives of Canada, she kindly agreed to provide input and to revise this paper.

Long-term preservation of paper archives produced since the middle of the nineteenth century represents a major challenge for the archival and library communities. The massive use of wood pulp to produce newspapers, books, and records has made a large portion of the documentary heritage vulnerable, particularly to acidity. Like many other cultural organizations, the National Archives and the National Library of Canada both have been searching for long-term solutions to this ongoing problem. For the past 15 years, the National Archives of Canada has been operating a Mass Deacidification System that has allowed the protection of more than half a million books. In this article, the author summarizes the system, discusses the results achieved, and ponders the problems raised by its operations and its accompanying major management challenges.

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My purpose in this paper is not to sing the praises of the Mass Deacidification System that has been in operation at the National Archives of Canada for more than ten years, nor to explain its technological details.[1] Rather, this paper will summarize this system, essentially emphasizing its development and what it is and what it does; discuss the results it has produced; and, finally, ponder the problems raised by its operation and its accompanying management challenges.

Mass Deacidification at the National Archives of Canada

Perhaps the best starting point for discussing and describing the Mass Deacidification System in operation at the National Archives of Canada is a recollection of some of the factors that led the National Archives of Canada and the National Library of Canada to see mass deacidification as a viable solution to the enormous problem of permanently preserving paper. Six factors contributed to the search for a solution:

1. Starting in the middle of the nineteenth century, wood pulp replaced principally cotton rags as the main material in paper. This replacement lies at the root of the problems we are experiencing now.
2. Since that replacement, there has been massive use of papers, made both of mechanical wood pulp and chemical wood pulp treated with bleaching and sizing agents, to produce newspapers, books, and other types of paper documents that today constitute the documentary heritage of the past one and one-half centuries.
3. This paper is vulnerable to acidity. Not only is acid inherent in wood pulp, but acidity is to a large extent due to the various forms of chemical degradation caused by the use of strong acids during bleaching or sizing, by the action of ultravioliet radiation on the cellulose and noncellulose components of the paper, or by atmospheric pollution.
4. These deterioration agents all affect the paper fiber to varying degrees, increasing its acidity, making the fiber less flexible and more brittle, accelerating the process of self-deterioration, and so on. We are already familiar with the consequences of these processes on the majority of documents preserved in libraries and archives.
5. Since acidity has been identified as the main agent in the deterioration of paper and the shortening of its life, deacidification appeared to be one of the major solutions to the problem of long-term preservation of information printed or recorded on paper—a major solution, though not the only one. In fact, from the long-term conservation standpoint, the paper-strengthening processes, modified paper-manufacturing processes, and preservation of paper-based archives under controlled environmental conditions may be solutions of equal or even greater value.
6. Deacidification—whether of one item at a time or in quantity—is essentially intended to neutralize the acids contained in the paper. From a conceptual point of view, the process seems relatively simple, involving the addition of an alkaline reserve, consisting of calcium or magnesium carbonate, in a way that subsequently neutralizes the deteriorating action of the acids and thus extends the life of the paper significantly.

[1]For that aspect, the literature on the subject is plentiful. See, for example: Astrid-Christiane Brandt, *Mass Deacidification of Paper: A Comparative Study of Existing Processes* (Paris: Bibliotheque Nationale, 1992); George Martin Cunha, "Mass Deacidification for Libraries: 1989 Update," *Library Technology Reports* 25 (January–February 1989): 17–82; and Anne Liénardy and Philippe Van Damme Philippe, *La désacidification de Masse des livres et documents*, (Brussels, Institut Royal du Patrimoine Artistique, 1992).

We must go back as far as the early 1970s to find the earliest indications of interest by the National Archives of Canada in the deacidification process, designed by Richard Smith and known today as the WEI T'O process. Our own records tell us the following. After developing the nonaqueous deacidification process in the early 1970s, Smith was invited in 1974 by the Public Archives of Canada to submit a pilot project proposal. In the next two years, the Treasury Board of Canada authorized capital expenditure for the development of a prototype system, and during the 1976–77 fiscal year, the first tests led to the prototype. In 1979, the system as we know it today was virtually in place. By 1982, the first production reports showed that the National Archives of Canada's Mass Deacidification System was operational.

The chemical agent used by the WEI T'O process in deacidification is methylmagnesium alkoxide dissolved in methanol and mixed with two cosolvents—chlorodifluoromethane (HCFC 22) and 1.1 dichloro-1-fluoroethane (HCFC 141B)—whose purpose is to carry the deacidifying agent into the paper fibers. By means of a chemical chain reaction, this compound protects the very fiber of the paper against the devastating action of acid.

Application of the process requires the establishment of a four-stage procedure:[2]

- *Quality control and testing* Books are selected and their susceptibility to the deacidification process is evaluated.
- *Vacuum drying* Selected books are dried for 36 hours to avoid exposure of the magnesium alkoxide to water.
- *Deacidification* Actual treatment with deacidifying agents.
- *Overnight recovery, conditioning, and inspection* Reconditioning of the material for 24 to 48 hours to readapt it to the ambient atmospheric conditions.

The deacidification stage is the high point in the process. After the material to be treated has been prepared and predried, and the process tank has been loaded, actual deacidification takes place. It consists essentially of first eliminating the air from the material to be treated; pumping and circulating the treatment solution from the storage tank to the process tank for about 10 minutes; and finally, after the treatment has been completed, returning the excess solvent to the storage tank and recovering part of the solvent for reuse.[3]

Overview of the Results Obtained

The least we can say is that there is no consensus about the value and merit of the system. Its designer highlights its good points and its potential for development. The engineers and technologists who worked on its installation and maintenance point to its strengths, its potential for adjustment, and its limitations. Furthermore, experts from the Library of Congress, who visited the National Archives of Canada facilities in 1991, offered some opinions that, although cursory, will probably be useful for the future. Finally, researchers concerned with the effects of deacidification on the durability of paper indicate that deacidification methods stabilize different kinds of papers to varying degrees.

But the researchers also identify certain possible limitations of a rather troublesome nature. It is not necessarily easy to evaluate the system, for which the cost of operation in 1991–92—for everything considered to-

[2]Richard Smith, *Mass Deacidification at the Public Archives of Canada*, in Guy Petherbridge, *Conservation of Library and Archive Material and the Graphic Arts*, (London: Butterworths, 1987), p.126.

[3]For a detailed list of the eleven treatment steps see Smith, *Mass Deacidification.*

gether—was very nearly $300,000, Canadian.

Under the circumstances, a return to the objective facts might be useful:

1. The WEI T'O system is being used by the National Archives of Canada to deacidify books and not archives.
2. Between April 1989 and March 1992, the average number of books deacidified yearly has been 44,000.
3. In 1992–93, 1993–94, and 1994–95, the system was operating five days a week, 24 hours a day, for an average production of 162,000 treated books per year.
4. As a rough calculation, setting equipment investment at $1 million (to be amortized over ten years), and taking as indicators the operating and maintenance costs and production levels for 1986–87 and 1991–92, we obtain the following average costs per treated book and per pound: 1986–87, $17 per book and $24.3 per pound; 1991–92, $7.1 per book and $13 per pound.

What have we gained from all this? More than half a million volumes have been protected against acid deterioration, as clearly suggested by the results of tests done for the Library of Congress, the research by Helen Burgess at the Canadian Conservation Institute, and the pH and double-fold tests done on treated and artificially aged paper. We have an operational system whose performance in terms of cost is improving. We have gained substantial expertise in the operation and administration of the system.

Our system does not, however, solve everything, and its use of alcohol still precludes the treatment of certain inks and certain other materials used in the manufacture of books, such as plastics and adhesives. There is, hence, the need to invest in the preselection of books to be treated—30 percent of the books cannot be treated—and we confront the virtual impossibility, mostly because of the variety of inks used, of mass deacidification of archives.

Considering the average production of 60 books per treatment cycle and a maximum of about 160,000 books per year, and considering the energy required for preselection, it could be argued that we can hardly refer to this as mass treatment. Yet, judging from the comparative data currently available, the National Archives of Canada is approaching that goal. However, the work is tremendous and the rate must be increased if we want to protect the millions of items produced over the past 150 years in reasonable time.

Challenges for the Future

The challenge we are facing, whatever system we use, is quite simply enormous, as indicated by the expectations expressed as criteria by our colleagues from the Library of Congress. Citing from them, we want a process that

- is effective from both the chemical and technological points of view, without affecting in any way whatever the physical structure of the treated material or the paper components, the inks, the color, and so on.
- can be applied universally to all types of documents, of any shape and size, with books and archives mixed together.
- requires very little if any preselection.
- has no adverse impact on the environment or the health of the system operators.
- is financially affordable.
- provides a solution to the enormous problem of degradation in paper caused by acid within an acceptable timeframe.

Our expectations are no less stringent in Ottawa and elsewhere in Canadian libraries and archives. I even see that the National Library and the National Archives origi-

nally expected the system also to "establish physical and chemical conditions that would facilitate subsequent strengthening, stabilization or restoration treatments." Nothing less! With such exacting parameters—the importance of which I understand, although one could wonder if this is not a lot to require from a single system—the magnitude of the challenge has become quite clear.

Environmental issues. From an environmental standpoint, for example, the provisions of the Montreal Protocol and the national statutes and regulations governing the use and importation of Freon forces us for now to comply with quotas and to buy Canadian. Recently we have introduced the use of HCFCs (hydrochlorofluorocarbons), a replacement solvent that meets current environmental requirements, that has the properties of previous solvents, and that offers a reduced "ozone depletion factor."

Technical issues. On the technical side, the task is no less demanding. The preliminary results of research at the Canadian Conservation Institute on this mass deacidification process has shown some unevenness in the distribution of the buffer deposit in all cases. Of particular interest is the fact that, with the WEI T'O process, unsized paper—that is, porous paper—seems to absorb a very high level of solution, which may be harmful in the long term. If the investigation now under way confirms this hypothesis, and if the degree of harm is significant, some answer must be found.

Moreover, and more important for now, we must increase the treatment capacity of the system. We recently enlarged our reconditioning facilities and are actively working to install a solvent recovery system that will enable us to double our current recovery capacity of 35 percent. By doing this, we are reducing ozone-depleting emissions immediately and putting ourselves in a position to reduce further our supply costs over the longer term. We are also presently discussing the enlargement of the treatment chamber to enable deacidification of more material in each treatment cycle. Again, not everything is simple—experts have advised that, if the chamber is overly enlarged, the deacidifying agent may not penetrate the books evenly and may fail to penetrate some at all.

Operational issues. Basic operational issues were raised in April 1992 during a working session that brought together scientists and administrators from Canadian libraries and archives. Faced with the mass of material to be treated, the participants wondered if all the books produced in the last century need to be deacidified. If the answer is no, which seemed to be the opinion of a number of people, perhaps the first task is reaching agreement on the selection criteria for the material that must be treated.

Moreover, the inability of the system to treat archival material is obviously disappointing. Again, not everything must be deacidified. But of the material that absolutely must be treated, do we have an idea of the variety of inks, and can we find a deacidifying agent that does not affect the physical properties of the recorded information? Unless there is a satisfactory answer, we must definitely work with our archives clients to find a viable alternative. The first that comes to mind, one with which archivists obviously are familiar, is the transfer of the information to other media. There are other solutions, such as the preservation of archives in a controlled environment, in acid-free containers. But all solutions have a cost, and we must determine what they provide in cost-benefit terms compared with those of a hypothetical system of mass deacidification capable of accepting and effectively treating a wide variety of paper-based archives without preselection.

Finally, the cost of the present system must be considered. Are the treatment costs

per book acceptable? Can they be reduced? Considering the mass of items to be treated and the benefits to be derived, is the investment worth its price? For we must not deceive ourselves—we are talking about tens and even hundreds of millions of dollars across North America for the next few years alone. Are there less expensive solutions that are just as viable?

All these questions are still poorly formulated, partly because everybody has been so preoccupied with concerns about the effectiveness and viability of the processes being examined. It does not seem that these matters have been the subject of in-depth analyses or have received even partial answers.

Conclusions. In spite of the limitations indicated here, the National Archives of Canada experiment has provided interesting results about the viability of mass deacidification processes and has extended the life of half a million books. This is no small contribution.

However, much remains to be done beyond the search for the most suitable system to protect from damage by acidity our documentary heritage on paper. As a society, we must first know what records we want to preserve, and at what price. Answers, even partial answers, to these two questions, one of which is fundamental, would help the experts find the most suitable system or systems for our needs.