

Paper Degradation and Acidification in Progress

A study into the effects of 14 years of natural aging on the quality of paper in the collections of the Koninklijke Bibliotheek and the National Archives in the Netherlands

A joint research project of the Koninklijke Bibliotheek (National Library of the Netherlands), and the National Archives, commissioned by *Metamorfoze*, the Dutch National Program for Conservation of Library and Archive Materials.

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In more condensed form of journal articles, research reports will be submitted for publication in the conservation scientific community in 2007.

Summary & Conclusions

In 1990 an extended inventory damage survey was performed in the collections of the Koninklijke Bibliotheek and the National Archives in The Hague. The results of this survey had a strong impact in the Netherlands, and induced the Government to support a national approach of the conservation problem, leading to the set-up of the *Metamorfoze* program. The survey data and further analysis have formed the basis for the development of the selection and treatment procedures which are applied in this program.

An important, still unanswered question concerns the progression of paper decay and the relation between the degradation rate and certain paper properties. In order to obtain a quantitative impression of the paper deterioration which occurred during the past years under current storage conditions, it was decided to repeat the measurements of the paper characteristics performed in 1990 and compare the new findings with the earlier ones. After a pilot study in the Koninklijke Bibliotheek in 1996, a more extensive project was started in 2004 in co-operation with the National Archives. In this project approximately 400 books and archival documents, belonging to the series of test materials studied in the 1990 survey, were examined again, using the same test methods applied in 1990.

Comparison of the measurements in 1990 and 2004, statistical analysis and discussion of the results, have improved our insight into the nature and extent of the natural aging process of paper. The major conclusions are as follows:

- Documents with the most acid paper show a significant decrease in paper strength in the course of 14 years of natural aging; the relation between this decrease in quality and a high degree of acidity of the paper is more prominent in books than in archive materials;
- There is a significant increase in acidity of the paper in the tested books in the course of the years. In case of the archival documents tested, this increase is not significant;
- Both in the tested books and the archival documents, a higher acidity (lower pH value) of the paper is combined with a smaller paper strength compared to paper with a lower acidity (higher pH value);
- The results of the study offer an experimental confirmation of the correlation between acidity and the rate by which the deterioration of paper proceeds, as is expected on theoretical grounds;

- The evident instability of acid paper, the increase in acidity (acidification) during storage and consequently the extension of this problem in the future, underline the necessity to maintain deacidification treatment as an essential, indispensable part of an adequate conservation strategy for library and archival collections;
- In the tested books, the rate of loss of paper strength is significantly higher for yellow/brown discolored paper compared to non-discolored paper; in case of the tested archival materials, both the discolored and non-discolored papers do not show a significant change in paper strength in the course of years;
- The presence of yellow/brown discoloration is combined with a smaller paper strength compared to non-discolored paper, both in the tested books and the archival documents;
- The results of the investigation of the books confirm the correlation, also found in other studies, between the discoloration of paper and the rate of paper degradation: discolored paper has a far less good prognosis, shows a faster deterioration than non-discolored paper;
- Although the relation of paper strength with acidity and discoloration is less clear in the archival documents as compared to the books tested, in general the same trend can be observed. A growing proportion of the paper becomes acid and acid paper degrades at a faster rate. Three possible explanations for the difference between archive materials and books are indicated: (i) the sorts of paper used in archival documents usually differ from those in books, (ii) archival documents commonly show a less compact structure than books, which may be advantageous in this respect, and (iii) the archive materials tested are stored in air purified depots, whereas the books are not;
- In the light of 'eternity', 14 years of natural aging is very short to allow all, often slowly in time developing changes to become manifest and detectable. Continuation of monitoring the effects of natural aging for a longer period in the future is therefore needed. In this regard, sufficient precautions are necessary to guarantee that future analyses will be performed under the same testing conditions and with the same testing procedures as applied previously.