

## Appendix D

# Suggestion for Standard Paper Testing for Deacidification Quality Control by National Bureau of Standards

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This appendix lists procedures recommended for assessing the stability of book papers before and after treatment with diethylzinc. The procedures were recommended by Edwin Parks of the National Bureau of Standards Ceramics Chemistry and Bioprocesses Group. The appendix consists of two parts:

1. List A consists of routine tests suitable for quality control during the engineering program. With the exception of fiber strength analysis by zero span tensile testing, most of the tests have been used by the Library of Congress in their development of the diethylzinc process. One modification of an aging technique is recommended, that is, humid aging at 75° C and 50 percent relative humidity.
2. List B consists of more time-consuming research tools that may not be practical in the context of a large-volume testing program.

### *Technology for Assessing the Effectiveness of Paper Preservation by Treatment With Diethylzinc (DEZ)*

#### Recommended Procedures

1. Accelerated aging techniques (to be performed before and after DEZ treatments)
  - a. *Dry air*  
"Standard test method for relative stability of paper (effect on folding endurance). " ASTM Designation D-776-65
  - b. *Humid air*
    - (1) 75° C, 50 percent relative humidity
    - (2) 90° C, 50 percent relative humidityCommercial ovens may be employed, combining wet bulb temperatures of 59.5 and 730 C and dry bulb temperatures of 750 C and 90° C, respectively. Aging periods and sampling intervals to achieve significant decreases in strength will vary with types of paper. Twelve days is likely to be more than sufficient.
2. Testing procedures (to be performed before and after accelerated aging)
  - a. *Folding endurance*  
"Standard test method for folding endurance of paper by the MIT tester. " ASTM Designation:

D-2176-69. Method allows for pressures of 0.5 to 1.5 kg, but even the lowest pressure may be too severe for deteriorated book papers.

- b. *Fiber strength (zero-span tensile strength)*  
Not a standard procedure. Zero-span tensile tests can be performed with an IPC (Institute of Paper Chemistry) zero- span clamp attached to the jaws of a conventional load-elongation machine. However, we recommend a machine dedicated to zero span tensile determinations.  
This is a quick, simple physical test that may be applicable to degraded book papers which would not survive even a single fold, but might still have useful life if the DEZ method prevents further degradation.
- c. *Hot water extractable acidity or alkalinity of paper.* TAPPI method T-428 pm-77. Modifications of the standard method, as proposed by the Library of Congress, should be equally suitable for the extensive routine testing program envisaged.
- d. *Brightness of pulp paper, and paperboard (directional reflectance at 457 nm).* TAPPI standard Method T-452 em-83.

#### Supplemental Procedures

1. *Standard test method for copper number of paper and paperboard.* ASTM Designation: D-9 19-74.  
A suggested research technique only, not for routine qualitative assurance testing. This is thought to be a measure of carbonyl group concentration and may be correlated with carbonyl absorbance peak intensities in FTIR spectra. The prospect might then exist to use FTIR as a quick, non-destructive routine test.
2. *Wet tensile breaking strength of paper and paperboard.* TAPPI method T-456 em-822. For research and exploratory purposes only.
3. *Alpha cellulose in paper.* TAPPI method I-429 os-78. Alpha cellulose is a stable polymeric component of paper. This procedure uses strong alkali to extract components of less stability and lower molecular weight; hence, it is potentially useful for following the course of depolymerization during aging processes. A time-consuming and hazardous procedure to be used for specific research objectives, not as a routine test; not useful for papers containing lignin.