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## Effectiveness of paper deacidification processes

*Efficacité des procédés de désacidification du papier*

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## Foreword

ISO (the International Organization for Standardization) is a worldwide federation of national standards bodies (ISO member bodies). The work of preparing International Standards is normally carried out through ISO technical committees. Each member body interested in a subject for which a technical committee has been established has the right to be represented on that committee. International organizations, governmental and non-governmental, in liaison with ISO, also take part in the work. ISO collaborates closely with the International Electrotechnical Commission (IEC) on all matters of electrotechnical standardization.

The procedures used to develop this document and those intended for its further maintenance are described in the ISO/IEC Directives, Part 1. In particular the different approval criteria needed for the different types of ISO documents should be noted. This document was drafted in accordance with the editorial rules of the ISO/IEC Directives, Part 2 (see [www.iso.org/directives](http://www.iso.org/directives)).

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. ISO shall not be held responsible for identifying any or all such patent rights. Details of any patent rights identified during the development of the document will be in the Introduction and/or on the ISO list of patent declarations received (see [www.iso.org/patents](http://www.iso.org/patents)).

Any trade name used in this document is information given for the convenience of users and does not constitute an endorsement.

For an explanation on the meaning of ISO specific terms and expressions related to conformity assessment, as well as information about ISO's adherence to the WTO principles in the Technical Barriers to Trade (TBT) see the following URL: [Foreword - Supplementary information](http://www.iso.org/foreword)

The committee responsible for this document is ISO/TC 46, *Information and documentation*, Subcommittee SC 10, *Requirements for document storage and conditions for preservation*.

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## Introduction

Archives, libraries and similar institutions store written and printed documents which they are obliged to retain on a permanent basis for cultural reasons and, in some cases, in order to meet legal requirements.

Often, the condition of these documents is endangered for a number of reasons. One of these is related to the manufacturing process used for more modern types of paper.

In the industrial age, paper-making processes underwent significant changes. One of the processes affected was sizing, which, in industrial processes, was achieved by mixing additives into the fibre suspension before shaping the sheets. These additives included acidic substances like aluminium sulfate. The reaction of the sizing agent eventually leads to formation of free acids. The acids act as a catalyst for the hydrolysis of cellulose, making the material brittle. Climatic influences aggravate this process, air pollution and cellulose degradation processes are a further source of acid in paper.

Another factor for paper stability is the raw material itself. For centuries, paper was made of textile fibres like linen, hemp or cotton rags which rather deliver stable, long-chain cellulose. The search for a more abundant raw material led to the invention to produce pulp out of wood by a grinding process. The resulting ground wood paper still contains most of the lignin and hemicelluloses, in addition to cellulose. The low pulp purity and the mechanical process causing a partial cutting of fibres lead to a much weaker paper. Compared to the older rag papers, ground wood paper is also less stable on the long run.

The problem of paper degradation due to acid has developed into a tremendous problem for archives and libraries. In addition to the processes for deacidifying single sheets, such processes having been used in conservation for a long time, the past few decades have seen new developments in technical processes which can be used on a large scale to retard the further decay of cultural assets as bound volumes and single sheets ("mass deacidification").

The aim of deacidification is to appreciably improve the life expectancy of paper. This is achieved by adding an alkaline substance to neutralize existing acid and slow down future acidic degradation for at least some time (buffering, alkaline reserve). Deacidification cannot improve the actual physical properties of the paper, but in combination with proper storage, it can slow down further decay.

Without validated analytical methods, it is not possible to assess whether a paper has been deacidified, or to what degree deacidification has been successful. This Technical Specification compiles the suitable measurements.



# Effectiveness of paper deacidification processes

## 1 Scope

This Technical Specification defines test methods and minimum requirements for paper deacidification processes regarding their effectiveness and consistency.

It is applicable for all large scale processes which offer deacidification of acid documents made of printed or hand-written paper.

Possible negative side effects of deacidification processes on the treated objects are not the subject of this Technical Specification. However, some general recommendations for how to cope with these side effects are given in [Annex A](#).

It is not specified either, which types of paper objects can be treated by large scale deacidification methods. Whatever currently available deacidification method is used, some objects might be excluded from treatment to avoid mechanical damage to paper and bindings or other unwanted side effects. The provider of the deacidification treatment should inform the customer about the limitations of the chosen method.

## 2 Normative references

The following documents, in whole or in part, are normatively referenced in this document and are indispensable for its application. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

ISO 535, *Paper and board — Determination of water absorptiveness — Cobb method*

ISO 536, *Paper and board — Determination of grammage*

ISO 776, *Pulps — Determination of acid-insoluble ash*

ISO 5351:2010, *Pulps — Determination of limiting viscosity number in cupri-ethylenediamine (CED) solution*

ISO 5626, *Paper — Determination of folding endurance*

ISO 5630-5:2008, *Paper and board — Accelerated ageing — Part 5: Exposure to elevated temperature at 100 degrees C*

ISO 6588-1, *Paper, board and pulps — Determination of pH of aqueous extracts — Part 1: Cold extraction*

ISO 9184-1, *Paper, board and pulps — Fibre furnish analysis — Part 1: General method*

ISO 9184-4, *Paper, board and pulps — Fibre furnish analysis — Part 4: Graff "C" staining test*

ISO 10716, *Paper and board — Determination of alkali reserve*

## 3 Terms and definitions

For the purpose of this document, the following terms and definitions apply.

### 3.1

#### **accelerated ageing**

artificially induced ageing under laboratory condition by increasing temperature and sometimes changing humidity or exposure to light in order to accelerate chemical reactions in paper like hydrolysis or oxidation to simulate processes usually occurring under natural condition but at a much slower speed

**3.2**

**alkaline reserve**

compound like calcium or magnesium carbonate neutralizing acids in paper

**3.3**

**average degree of polymerisation**

average number of anhydroglucose units (monomers of cellulose) in the cellulose macromolecule

**3.4**

**batch process**

deacidification process for a definite quantity of documents

**3.5**

**continuous process**

deacidification process for an indefinite quantity of documents

**3.6**

**deacidification**

neutralization of the organic and inorganic acids in the paper and deposit of an alkaline reserve as buffer against any subsequent acidic activity on paper

**3.7**

**extract pH**

value obtained in a water extract after the paper has been extracted under defined condition.

Note 1 to entry: Value measured with a glass electrode immersed in a definite quantity of water in which paper is dispersed in small pieces.

**3.8**

**folding endurance**

common logarithm of the number of double folds required to cause rupture in a strip of paper

**3.9**

**mass deacidification**

process of paper deacidification on a large scale

**3.10**

**process validation**

securing an operation according to preset parameters determined at processed objects

**3.11**

**routine monitoring**

monitoring carried out at regular intervals during normal operations

**3.12**

**side effects**

any unintended consequence caused by the execution of a treatment process

**3.13**

**test paper**

paper with characteristics defined in this Technical Specification, which is deacidified together with original documents and then analysed

**3.14**

**uniformity of deacidification**

homogeneous distribution of the alkaline reserve and pH across the entire sheet and within whole book blocks



## 4 Principle

Specified uniform test papers are treated together with customer's documents in a deacidification process. Afterwards, the test papers are examined using standardized test methods. The test papers are acidic and similar in their properties to common paper qualities produced in the period from around 1870 onwards. The usage of such papers ensures reliable results and allows comparing different batches, deacidification methods and treatment plants.

**NOTE** It is to be emphasized that successful tests according to this Technical Specification cannot guarantee that all documents treated in the process are deacidified to the same degree as the test papers. The result of a deacidification treatment strongly depends on the properties of the treated object, such as porosity, thickness, sizing, coating and acidity of the paper, etc. Therefore, it is impossible to guarantee that certain pH levels and alkaline reserve amounts are achieved in each object by the deacidification treatment. A passing of the tests means, however, that there is a high percentage of successfully treated objects.

## 5 Requirements

### 5.1 General

This Technical Specification defines test methods for “process validation” (initial testing) and “routine monitoring”. Process validation is used to prove that a technique fulfils its defined purpose. Routine monitoring is used to check that the effectiveness determined by process validation is being achieved in the course of the actual work. Routine monitoring, therefore, is based on process validation.

For “process validation”, extended test procedures should be carried out before and after accelerated ageing of the samples, including measurements of pH value, alkaline reserve, uniformity of deacidification and degree of polymerisation.

For “routine monitoring”, alkaline reserve of the test papers is examined.

### 5.2 Sampling

#### 5.2.1 Material

Both process validation and routine monitoring are performed using samples of test paper, some of which are deliberately not subjected to the deacidification process serving as a reference.

**Table 1 — Test paper**

	<b>Test paper (ground wood-free)</b>	<b>According to ISO standard</b>
Fibrous material	Fully bleached sulphite pulp with hemicelluloses	ISO 9184-1, ISO 9184-4
Kaolin filler	12 %–15 % kaolin	ISO 776
Grammage	80 g/m <sup>2</sup>	ISO 536
Surface finish	none	none
Sizing	approximately Cobb 60' 20 g/m <sup>2</sup>	ISO 535
Type of sizing	Alum rosin sizing Al <sub>2</sub> (SO <sub>4</sub> ) <sub>3</sub>	none
Surface sizing	none	none
Extract pH	approximately 5	ISO 6588-1
Optical brighteners	none	none
Acidity, given as negative alkaline reserve	approximately –0,3 % MgCO <sub>3</sub>	<sup>a</sup>
<sup>a</sup> Since no ISO standard is available, the German technical specification Zellcheming ZM IV/58/80 “Prüfung von Papier, Karton und Pappe...” can be applied. See Reference [2].		

### 5.2.2 Procedure

All samples should be examined within four weeks after treatment has been completed (including post treatment measures).

Before the paper is examined, any loose residues occurring as a side effect of the deacidification process should be removed by brushing.

## 5.3 Process validation

### 5.3.1 Frequency of sampling

A complete process validation is required every four years and, additionally, following

- changes to the process technology,
- changes of chemical components or their supplier, or
- changes of the test paper for routine monitoring.

The process validation is valid for all treatment devices of a production site that use the same process and technology.

### 5.3.2 Sample quantities and preparation of samples

The process validation is performed using identical test papers (i.e. same production batch). A quantity of 32 (+4, if folding endurance is included) test sheets, size A5 or larger, is needed for the necessary testing (see [Table 2](#)) of one treated sample set. Four treated sample sets are necessary for the process validation. The untreated sample set included, the sum of test sheets for one complete process validation is therefore 148 (+20, if folding endurance is included).

**Table 2 — Tested qualities and numbers of test sheets needed**

Tested quality	untreated test paper (one untreated sample set)		treated test paper (one treated sample set)	
	unaged	aged	unaged	aged
pH value (cold extraction)	4	4	4	4
Alkaline reserve	4	4	4	4
Uniformity of deacidi- fication			12	—
Cellulose DP	2	2	2	2
Folding endurance (op- tional)	(2)	(2)	(2)	(2)

For batch processes, the test papers should be placed into bound volumes which are thicker than 3 cm and feature a size of at least A5. For the first sample set, 32 (+4) test papers are placed evenly throughout the bound volume starting from page number 10.

The test papers should be centred vertically and placed as close to the spine as possible. The test papers should not extend outside the book block. The second sample set is prepared the same way, but placed in a different position in the treatment chamber. The third and fourth sample set should be treated on another day, and if applicable, in another treatment device. The positions of the samples in the chamber should be documented adequately.

**NOTE** Service providers can supply a constructional drawing of the deacidification device with the report and mark the positions of the books containing the test papers.