Durability 2000

Accelerateo ano Outooor Weathering Testing

Warren D. Ketola and John D. Evans, editors



Durability 2000: Accelerated and Outdoor Weathering Testing

Warren D. Ketola and John D. Evans, Editors

ASTM Stock Number: STP1385



ASTM 100 Barr Harbor Drive PO Box C700 West Conshohocken, PA 19428-2959

Printed in the U.S.A.

Library of Congress Cataloging-in-Publication Data

Durability 2000: accelerated and outdoor weathering testing
Warren D. Ketola and John D. Evans, editors.
p. cm.—(STP; 1385)
ASTM Stock Number: STP1385
Includes bibliographical references.
ISBN 0-8031-2856-8
1. Testing. 2. Accelerated life testing. 3. Weathering. I. Ketola, Warren D., 1948–
II. Evans, John D., 1967– III. ASTM Committee G3 on Weathering and Durability.
IV. ASTM special technical publication; 1385.

TA410.D78 2000 620.1'12—dc21

00-056917

Copyright © 2000 AMERICAN SOCIETY FOR TESTING AND MATERIALS, West Conshohocken, PA. All rights reserved. This material may not be reproduced or copied, in whole or in part, in any printed, mechanical, electronic, film, or other distribution and storage media, without the written consent of the publisher.

Photocopy Rights

Authorization to photocopy items for internal, personal, or educational classroom use, or the internal, personal, or educational classroom use of specific clients, is granted by the American Society for Testing and Materials (ASTM) provided that the appropriate fee is paid to the Copyright Clearance Center, 222 Rosewood Drive, Danvers, MA 01923; Tel: 978-750-8400; online: http://www.copyright.com/.

Peer Review Policy

Each paper published in this volume was evaluated by two peer reviewers and at least one editor. The authors addressed all of the reviewers' comments to the satisfaction of both the technical editor(s) and the ASTM Committee on Publications.

To make technical information available as quickly as possible, the peer-reviewed papers in this publication were prepared "camera-ready" as submitted by the authors.

The quality of the papers in this publication reflects not only the obvious efforts of the authors and the technical editor(s), but also the work of the peer reviewers. In keeping with long-standing publication practices, ASTM maintains the anonymity of the peer reviewers. The ASTM Committee on Publications acknowledges with appreciation their dedication and contribution of time and effort on behalf of ASTM.

> Printed in Baltimore, MD August 2000

Foreword

This publication, *Durability 2000: Accelerated and Outdoor Weathering Testing*, contains papers presented at the symposium of the same name held in New Orleans, Louisiana, on 25–26 January 2000. The symposium was sponsored by ASTM Committee G3 on Weathering and Durability. The symposium co-chairmen were Warren D. Ketola, 3M Traffic Control, Materials Division, and John D. Evans, DuPont Automotive.

Contents

Overview

CHARACTERIZATION

Salt Spray Performance Evaluation: Proposed Image-Analysis-Based Test Method—y. J. WARBURTON AND D. L. GIBBON	1
Comparative Study of Standard Weathering Test Methods Using Image Analysis—F. LEE, B. POURDEYHIMI, AND J. MARTIN	15
On the Use of Ion Scattering Spectroscopy to Predict the Outdoor Durability of Polymeric Films—R. R. ADKINS	35
Activation Spectra: Techniques and Applications to Stabilization and Stability Testing of Materials—N. D. SEARLE	41

OUTDOOR

Stationary Rack and Black Box Under Glass Exposures of Mineral Filled Polyethylene in Inland and Marine Tropical Climates—L. P. VELEVA AND A. VALADEZ-GONZALEZ	61
Accelerated	
Stress Analysis and Accelerated Test Design for Interior Light Environments—w. d. KETOLA, R. M. FISCHER, AND L. J. THOMAS	75
Exposure Test Results for Inkjet Inks in Interior Light Environments — R. M. FISCHER AND W. D. KETOLA	87
Advances in Accelerated Weathering Instrumentation Technology Using Advanced Control Systems—B. PATEL, F. LEE, AND K. SCOTT	103

Predicting the Durability of Building Stone Using Accelerated Weathering—	
S. A. BORTZ AND B. WONNEBERGER	116

Lightfastness of Artists' Pencils: Natural and Accelerated Exposure Results—	
P. J. BRENNAN AND E. T. EVERETT	133

Service Life

Calculation of the Spectral Irradiance of Solar Radiation for the Lifetime Prediction of Polymer Materials—D. KOCKOTT AND G. MANIER	151
Estimating the Durability of Roofing Systems—C. G. CASH	165
The Durability of Modern Sculptures Constructed of Glass—P. B. Adams and H. B. TRE'	176

Overview

Weathering and durability issues play an important role in the performance of many products that are used both outdoors and indoors. Products used in both environments are exposed to degradation caused by light, heat, moisture and the effects of pollutants. Customer expectations for durability are increasing and today's market often requires faster introduction of new products. These factors require a better understanding of the exposure stresses in both indoor and outdoor environments, more reliable laboratory accelerated tests, and analysis techniques that provide for more precise characterization of the changes caused by exposure.

STP 1385 represents the work of a number of researchers presented at Durability 2000: Accelerated and Outdoor Weathering Testing, January 25 and 26, 2000, in New Orleans, Louisiana. This was the third in a series of symposia sponsored by the ASTM G3 Committee on Weathering and Durability in its continuing effort to promote research leading to advances and innovations in durability testing. The papers presented in STP 1385 are divided into three categories: (1) characterization of materials that have been subjected to exposure tests; (2) advances in understanding or new developments in either outdoor, indoor, or laboratory accelerated tests; and (3) service life prediction.

Material Characterization

Many products or materials are evaluated using visual inspection for changes in important appearance or other attributes caused by exposure. These visual inspections can be imprecise because of differences in assessment criteria of those conducting the evaluation. The papers by Warburton and Gibbon and Lee et al. describe the use of images analysis techniques that can significantly improve the repeatability and reproducibility of appearance characterization of a variety of materials, appearance attributes, and exposure tests. Very long laboratory accelerated or outdoor exposures are often needed to produce measurable changes in physical properties of a material. Analytical techniques that can detect changes that correspond to loss of physical properties can significantly shorten exposure times needed to evaluate different materials or material formulations. Adkins reports on the use of ion scattering spectroscopy to measure H/C and O/C ratios as a function of depth in materials exposed for 500 hours in a laboratory accelerated test. The H/C and O/C ratios correlated with physical property changes produced in long term outdoor exposures of the same materials. In many cases it is important to know which spectral regions of the light source used for exposure are primarily responsible for degradation. Searle describes monochromatic and polychromatic techniques for determining this "activation spectrum" of a material and shows it can be used for the development of more light stable materials and in the design of laboratory accelerated tests.

Developments in Outdoor, Indoor, and Laboratory Accelerated Exposure Tests

The type and rate of degradation may vary significantly with the type of climate where a product is used. Veleva and Valadez-Gonzalez report on black box under glass exposures of mineral filled polyethylene that were conducted in two different climates. This research showed that for black box under glass exposures of this material, the degradation mechanism did not change, but the rate of degradation was related to differences in specific climate

parameters. Ketola et al. and Fischer describe the development and evaluation of a laboratory accelerated test to simulate a specific indoor light environment. Results from the new test are compared to those from conventional laboratory accelerated test in order to determine which can best be used to estimate long term color stability of a series on ink-jet inks. Patel et al. describe improvements in techniques used to control irradiance, temperature, and humidity in laboratory accelerated exposure tests and show how more modern equipment can provide more consistent exposure conditions. Bortz and Wonneberger report on the development of a laboratory accelerated exposure test that has been successfully used to estimate the long-term durability of building stone. This test is based on a cyclic freeze/thaw immersion of the stone material in acidic solution that simulates the effects of exposure in polluted environments. Brennan and Everett report on results from outdoor and laboratory accelerated exposure tests that are being done as part of an effort to develop a new ASTM standard for assessing lightfastness of artists' colored pencils. In general, performance ranking produced better agreement between the tests than a rating system.

Service Life Prediction

Predicting service life of materials is the ultimate goal of any exposure program. Meaningful predictions of service life are contingent upon reliable measurements of the exposure stresses that can affect durability. Kockott and Manier describe a computer model that can be used to determine the spectral power distribution of daylight in many different locations. This program can be used to more realistically estimate the radiant exposures in critical spectral regions in a variety of climates, Cash reports on a method for estimating the durability of a variety of roofing materials based on thermal load and various construction and design parameters. Adams and Tré show how characterization of the properties of a glass and its response to accelerated environmental stresses can be used to determine that a sculpture made of the glass will remain relatively unchanged for at least 20 years.

Significant advances have been made in exposure tests and the methods used to characterize materials that have been subjected to exposure tests. Some of these advances may ultimately be incorporated into ASTM standards describing durability tests or methods for material characterization. The ASTM G3 Committee is committed to promoting this research. We hope that you find the advances reported in STP 1385 helpful in your research and encourage you to participate in the work of the ASTM G3 Committee.

> Warren D. Ketola 3M Traffic Control Materials Division St. Paul, MN Symposium Co-chairman and editor

John D. Evans DuPont Automotive Troy, MI Symposium co-chair and editor

ISBN 0-8031-2856-8