STP 1454

Flammability and Sensitivity of Materials in Oxygen-Enriched Atmospheres:

10th volume

Editor(s):

Theodore A. Steinberg,
Barry E. Newton,
and Harold D. Beeson

ASTM INTERNATIONAL
Standards Worldwide

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ASTM Stock Number: STP1454

ASTM International
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

Photocopy Rights

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 International 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.

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Printed in Bridgeport, NJ
2003

Foreword

This is the 10th in a series of Special Technical Publications produced by ASTM Committee G4 on *Flammability and Sensitivity of Materials in Oxygen-Enriched Atmospheres*. The papers contained in this volume were produced as a result of the Tenth International Symposium on Flammability and Sensitivity of Materials in Oxygen-Enriched Atmospheres held in Brisbane, Queensland, Australia in November 2003. This volume was edited by Theodore A. Steinberg, Division of Mechanical Engineering at the University of Queensland, Brisbane, Queensland, Australia; Barry E. Newton, Wendell Hull and Associates, Inc., Las Cruces, New Mexico; and Harold D. Beeson, NASA White Sands Test Facility, Las Cruces, New Mexico.

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MISCELLANEOUS

Overview

This is the 10th Special Technical Publication (STP) originating from ASTM Committee G4 that focuses on the Flammability and Sensitivity of Materials in Oxygen-Enriched Atmospheres. As in past STPs, the contents of this 10th volume share and expand on the G4 Committee's consistent objectives set out when the first STP was published in 1983. These objectives include:

- Provision of a readily accessible reference addressing oxygen compatibility—A subject still not addressed in any focused fashion in the open literature elsewhere;
- Ongoing contribution to the construction of a growing database on the most current risk management concepts, practices, approaches, and specific procedures used by individuals and organizations involved in the design, use, retrofitting, maintenance and cleaning of oxygen systems;
- The ongoing provision of the most current, unique, and valuable data specifically related to the flammability and sensitivity of materials in oxygen-enriched atmospheres that is indispensable to a) designers, users, manufacturers, and maintainers of oxygen components and systems; b) support the continually in-demand Committee G4's Technical and Professional Training Course: Fire Hazards in Oxygen Systems and Oxygen Systems Operation and Maintenance; and c) application in the many ASTM Committee G4 guides, practices, test methods, and standards;
- The provision of guidance to the G4 Committee on future areas needing development relating to the flammability or sensitivity of materials and the environments that support oxidation of these materials; and
- Provision of models and the data on which to validate these models that specifically focus on industrially relevant situations that involve the flammability or sensitivity of materials in oxidizing atmospheres.

This volume consists of a group of peer-reviewed publications of work that was also presented at Committee G4's 10th International Symposium held in Brisbane, Queensland, Australia in November of 2003. This 10th volume contains 28 papers on topics that have been included and important to the G4 Committee since it began focusing on this important topic. These topics are included under the common section headings: Ignition and combustion of nonmetals, ignition and combustion of metals, failure/hazard analysis and safety, and miscellaneous.

The first section of this STP, "Ignition and Combustion of Nonmetals" contains six papers. The first paper presents a valuable review of the resistance of polymers to ignition by pneumatic impact. This is followed by three papers related to the assessment of nonmetallic materials that are used in oxygen systems with a focus on toxicity. This is an especially important area requiring attention as new standards are being developed and introduced relating to the use of fluorinated materials in oxygen systems that are used in medical applications. This is followed with a statistical evaluation of upward flammability testing (NASA STD 6000 Test 1). The final paper in this section addresses the ignition of materials exposed to liquid oxygen by mechanical impact and compares the ignitability of the materials evaluated in air to the time required to return to this ignitability after exposure to liquid oxygen.

The second section of this STP, "Ignition and Combustion of Metals," is the largest containing ten papers. The first paper presents work evaluating metallic filters for use in oxygen systems, an especially important topic since standard promoted-ignition test results for 0.125 in. (3.2 mm) diameter cylindrical rods have been shown to be of limited validity in the evaluation of filter materials caused by the different configurations present. The next two papers present results obtained with a unique ultrasonic system used to measure the melting rate of the metal rods while burning in oxygen in both normal gravity and reduced gravity. These two papers are followed with a paper presenting the results of the evaluation of stainless steel promoted ignition tests under flowing conditions. These results are important since there are significantly different results than obtained under static conditions (standard testing) and have implications on the use of stainless steels (and indeed other materials) in oxygen-enriched environments. Next, is a related paper in which a model is presented for the ignition of rods and tubes in flowing oxygen. The promoted ignition of structured aluminum packings in oxygen when diluents are present is the subject of the next paper followed by the microanalysis of aluminum rods that were burned in oxygen and either quenched or self-extinguished. The final three papers of the second section present the results of several promoted ignition-combustion test programs. The first examines the burning of cast and wrought alloys, the second the effects of sample thickness on several alloys, and the third the burning of tubular aluminum testing in both liquid and gaseous oxygen.

The third section of this STP, "Failure/Hazard Analysis and Safety," contains seven papers focused on either the documentation of failures and their causes or techniques being used/developed to analyze systems/components operating in oxygen-enriched atmospheres to ensure system functionality and personnel safety. The first paper presents a new technique for analyzing large systems based on prioritizing system components based on operating conditions. This approach identifies the system's "high-risk" components requiring immediate analysis and lower risk components that do not require immediate analysis. This is followed by an analysis of the space shuttle external tank pressurization system and next a failure analysis of fires that have been occurring in oxygen production process valves. An informative review of some incidents in oxygen systems that have occurred in Australia over a 30-year period is the subject of the next paper. Cause and origin analyses of fires are the subject of the next two papers; first on two large industrial oxygen valves and next on an underwater breathing apparatus. This section concludes with the presentation of an electronic database being used by NASA White Sands Test Facility to perform and archive oxygen system/component hazards analyses.

The final section of this STP contains five papers on diverse subjects relevant to the study of flammability and sensitivity of materials in oxygen-enriched atmospheres. First presented is a parametric model examining nonmetallic materials that are contaminated or damaged being used in oxygen environments. Optical techniques used to view oxygen system fires are presented next. This is followed by a description of an in-situ pipe cleaning technique utilizing solvents and the contaminants introduced to oxygen systems solely caused by the connecting and disconnecting of pipe connections. The final two papers of this section present the results of two important test programs. The first presents the results from an interlaboratory test program using ASTM's new standard (G127) to evaluate regulators for use in oxygen-enriched atmospheres. The second presents the effect of machining and molding on the characteristics of Neoflon™, important as this material is often being used in replacement of Kel-F™, which is no longer commercially available.

This 10th volume on *Flammability and Sensitivity of Materials in Oxygen-Enriched Atmospheres*, provides an invaluable source of new information and is highly relevant to in-

dividuals and organizations that own, operate, or in any way interface with oxygen systems or oxygen-enriched atmospheres.

Theodore A. Steinberg
Division of Mechanical Engineering,
The University of Queensland
Brisbane, Queensland, Australia
Symposium chairman and editor

Barry E. Newton
Wendell Hull & Associates, Inc.
Las Cruces, New Mexico
Symposium chairman and editor

Harold D. Beeson
NASA White Sands Test Facility,
Las Cruces, New Mexico
Symposium chairman and editor

Cover image courtesy of NASA White Sands Test Facility

ISBN # 08031-3470-3
Stock #: STP1454

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