Flammability and Sensitivity of Materials in Oxygen-Enriched Atmospheres

Sixth Volume

Janoff/Stoltzfus, editors

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Flammability and Sensitivity of Materials in Oxygen-Enriched Atmospheres: 6th Volume

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Each paper published in this volume was evaluated by three peer reviewers. 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 printed "camera-ready" as submitted by 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 these peer reviewers. The ASTM Committee on Publications acknowledges with appreciation their dedication and contribution to time and effort on behalf of ASTM.

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Foreword

The Sixth International Symposium on Flammability and Sensitivity of Materials in Oxygen-Enriched Atmospheres was presented at Noordwijk, The Netherlands, from 11 to 13 May 1993. The symposium was sponsored by ASTM Committee G-4 on Compatibility and Sensitivity of Materials in Oxygen-Enriched Atmospheres. Kenneth McIlroy, Praxair, Inc., Linde Division, and Mike Judd, European Space Agency/ESTEC, served as cochairmen of the symposium.

Acknowledgment

The quality of papers in this publication reflects not only the obvious efforts of the authors but also the unheralded work of the reviewers. Coleman Bryan, Barry Werley, Kenneth McIlroy, Richard Paciej, Len Schoenman, Melvyn Branch, Michael Yentzen, Bill Royals, Marilyn Fritzemeier, Dwight Janoff, and Joel Stoltzfus acted as review coordinators, enlisting appropriate reviewers and ensuring that reviews were completed properly and submitted on time. The editors also wish to acknowledge Rita Hippensteel for her efficient and diligent assistance in preparing this document.

Joel M. Stoltzfus
Dwight D. Janoff

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MISCELLANEOUS

Overview

The purpose of the symposium on flammability and sensitivity of materials in oxygen-enriched atmospheres was to build upon the foundation provided by previous symposia. The aim was to:

- provide a reference text on a subject that is not widely addressed in accessible literature,
- build a reference of the concepts and practices used in designing oxygen systems,
- provide a data base to support the use of ASTM Committee G-4 guides and standards, and
- serve as a guide to Committee G-4 members in their future efforts to address the problems of oxygen-use safety.

This volume, in addition to those from previous symposia (STP 812, 910, 986, 1040, and 1111), is an important resource on the subject of the proper use of materials in oxygen-enriched environments. Committee G-4's contribution to the resources on the subject also include four standard guides (G 63, G 88, G 93, and G 94), three standard test methods (G 72, G 74, and G 86), and a fourth test method for determining the promoted ignition and combustion properties of metallic materials that is currently being balloted. The latest contribution is a Standards Technology Training course entitled "Controlling Fire Hazards in Oxygen-Handling Systems." In this course, attendees are taught to apply the available resources to improve the safety of oxygen-handling systems. We are confident that this volume will be a welcome contribution to the subject.

This STP comprises six sections. The first section presents two papers on the development and evaluation of test methods. Werley proposes an approach to more cost-effective gaseous impact testing. Sidebotham et al. presents a new test method for determining the minimum oxygen concentration to support an intraluminal flame. These papers may provide the impetus to develop new standard test methods or to modify existing ones.

The second section, which addresses the ignition and combustion of polymeric materials, comprises four papers. Wolf et al. discuss the spontaneous ignition temperatures of tracheal tube materials. This work extends previous work on oxygen index and flame spread in materials used in operating rooms. Bruley and de Richemond discuss recommendations for preventing fires in the oxygen-enriched atmospheres that may occur during surgery. The effects of diluent gases in oxygen on the flammability of polymers at high pressures is discussed by Hirsch and Bunker. They observe that at some pressure between 20.7 and 34.5 MPa, even the most burn resistant polymers become flammable in air, indicating that high-pressure air systems require enhanced safety precautions. Finally, Shelley et al. study the effect of hydrocarbon oil contamination on the ignition and combustion properties of PTFE tape in oxygen.

Seven papers comprise the third section in which data on the ignition and combustion of metals and alloys are presented and applied. These papers indicate the need for Committee G-4 to standardize the promoted combustion test method and provide a common set of definitions that can be used by experimenters in presenting their data. Steinberg et al. raise the question as to the applicability of metals flammability data obtained on earth to oxygen systems used in space. They point out that metals and alloys appear to be more flammable in a reduced-gravity environment than in a one-gravity environment. The final three papers in this section, along with the keynote address paper, discuss the application of metals ignition and combustion data to real systems; a process that requires the development and use of ones "technical judgment."

Regarding the paper on the promoted ignition-combustion behavior of carbon steel in oxygen-gas mixtures by McIlroy et al., a peer reviewer notes that these data suggest that 6-mm diameter rods of carbon steel are more flammable than 3-mm diameter rods at low pressures. This result contradicts the existing understanding of the role of dimension on metals flammability and is particularly significant if it is not the result of experimental technique.

The fourth section presents five papers in which specific ignition mechanisms are analyzed and discussed. The papers by Abbud-Madrid et al., Steinberg et al., and Shelley et al. discuss the development of models for the ignition of metals and alloys. This type of effort is absolutely necessary to identify and to begin to bridge the gaps in our understanding of the thermodynamic and kinetic processes involved in the ignition and combustion of materials. The better these processes and the parameters affecting them are understood, the more able we will be to build safer systems.

The paper by Shelley et al. concludes that polytetrafluoroethylene exhibits surface-burning. Our peer reviews have found this conclusion controversial. One reviewer does not feel the observations cited form an adequate basis to deduce surface combustion is occurring.

Structured packing materials for cryogenic air separation columns is the subject of the four papers in the fifth section. Werley et al. present a critical review of aluminum flammability data that is the cooperative result of several oxygen producers. This review, and the papers by Zawierucha et al. and Barthélémy, represent a large portion of the collective and individual work generated by a Compressed Gas Association task force.

The final section contains four papers on oxygen system safety, cleaning for oxygen systems, and a device for measuring wear and friction in high pressure oxygen. The paper on oxygen system safety by Koch represents a good "primer," offering guidance to individuals new to the subject. This paper will be appearing, in essence, as an appendix to ASTM G 88, "Standard Guide for Designing Systems for Oxygen Service."

These papers confirm that the objectives of the Symposium were met. The papers presented here (in conjunction with previous symposia volumes) provide a previously unavailable reference of oxygen system design concepts and practices. These volumes provide a data base that supports the use of ASTM Committee G-4 guides and standards. In addition, they serve as a guide to committee members in their future efforts to address the problems of safe oxygen use.

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