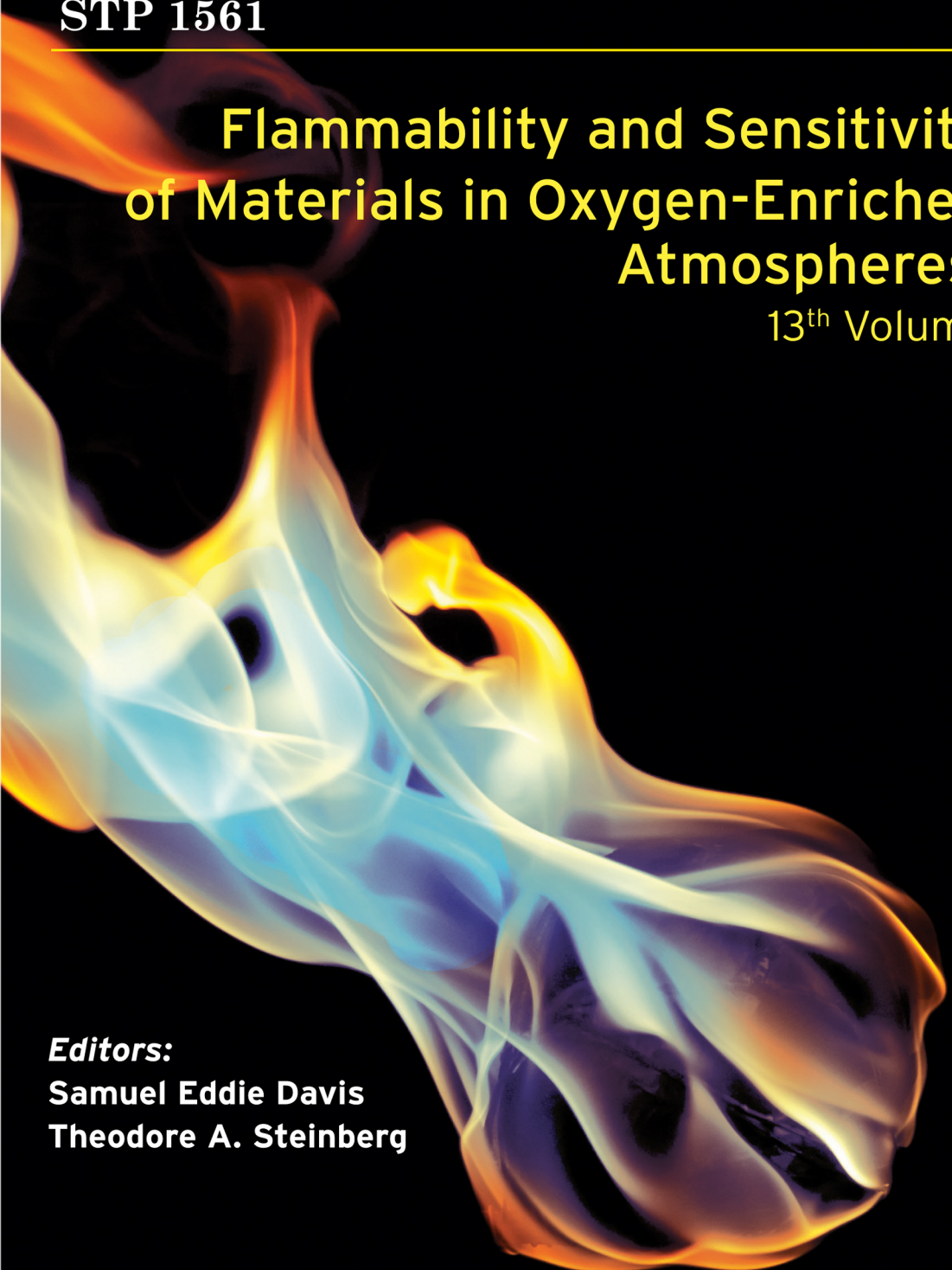
Selected Technical Papers

STP 1561

Flammability and Sensitivity of Materials in Oxygen-Enriched Atmospheres: 13th Volume



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Foreword

THIS COMPILATION OF *Selected Technical Papers*, STP1561, *Flammability and Sensitivity of Materials in Oxygen-Enriched Atmospheres: 13th Volume*, contains peer-reviewed papers that were presented at a symposium held September 19–21, 2012 in Montreal, Quebec, Canada. The symposium was sponsored by ASTM International Committee G04 on Compatibility and Sensitivity of Materials in Oxygen Enriched Atmospheres.

The Symposium Co-Chairpersons and STP Editors are Samuel Edgar Davis, NASA, George C. Marshall Space Flight Center, Huntsville, AL, USA, and Theodore A. Steinberg, Queensland University of Technology, Australia.

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Overview

STP 1561 is the thirteenth Special Technical Publication (STP) originating from the ASTM Committee G04 focusing on the *Flammability and Sensitivity of Materials in Oxygen-Enriched Atmospheres*. The twelve previous STP volumes originating from the ASTM G04 committee are: 812, 910, 986, 1040, 1111, 1197, 1267, 1319, 1395, 1454, 1479, and 1522. Copies of these STP volumes are available from ASTM, International.

The ASTM, International, G04 committee on the *Flammability and Sensitivity of Materials in Oxygen-Enriched Atmospheres* continues to grow in its international appeal. The thirteenth symposium was attended by a number of professionals representing several countries. These included the United States, Australia, Germany, Canada, France, Switzerland and Belarus. A number of professionals from other nations also attended the symposium and shared important information in person even though they were unable to submit a formal paper for publication.

As with the past STPs, the thirteenth volume expands upon the objectives that have been carried forward since the first ASTM Committee G04 STP was published in 1983. These objectives include:

- Review the current research on polymers and metals ignition and combustion;
- Overview principles of oxygen systems design and issues related to materials compatibility with oxygen; contribute to the knowledge on the most current risk management concepts, practices, approaches, and procedures used by individuals and organization involved in the design, use, retrofitting, maintenance, and cleaning of oxygen systems;
- Review of accident/incident case studies related to oxygen systems and oxygen handling procedures;
- Provide the most current data related to the flammability and sensitivity of materials in oxygen-enriched atmospheres to designers, users, manufacturers and maintainers of oxygen components and systems and to support Committee G04's Technical and Professional Training Course on Fire Hazards in Oxygen Systems.
- Discuss enhancement, development, and use of standards sponsored by ASTM Committee G04 on Compatibility and Sensitivity of Materials in Oxygen Enriched Atmospheres;
- Provide a readily accessible reference addressing oxygen compatibility.

The thirteenth volume consists of a group of peer-reviewed papers that were presented at the Committee G04's Thirteenth International Symposium held in Montreal, Quebec, Canada in September 2012. The volume consists of seventeen papers on topics related to ignition and combustion of non-metals, ignition and combustion of metals, oxygen compatibility of components and systems, analysis of ignition and combustion, failure analysis and safety, and includes aerospace, military, scuba diving, and industrial oxygen applications.

The papers presented in the thirteenth volume are arranged into six groups that offer a variety of valuable information. The first group of papers consists of three overview papers related to the development of safe oxygen systems. The first paper, submitted by NASA George C. Marshall Space Flight Center, is aimed at new users of oxygen systems and presents a concise, elementary discussion of the selection of materials for producing safe oxygen systems. The second paper, submitted by University of Alabama in Huntsville, discusses the effort and decisions that were required by a university to build the oxygen system for a rocket engine test facility. The third paper, submitted by NASA White Sands Test Facility, focuses on the effectiveness of different methods for field cleaning large oxygen system hardware.

The second group consists of five papers focusing on ignition mechanisms within oxygen systems and how to avoid them. The first paper, submitted by NASA White Sands Test Facility, discusses the elusive ignition mechanism called flow friction and if other ignition mechanisms may actually be mistakenly called flow friction. The second paper, submitted by Linde Engineering, evaluates the aluminum alloys common for air separation equipment and analyses the effects of contamination and elevated pressures on the most common aluminum alloys. The third paper, submitted by the BAM Federal Institute for Materials Research and Testing in Germany, discusses the severe ignitions that have occurred in their all-metal oxygen components which contain aluminum seals. The fourth paper, submitted by Air Liquide Corporation of France, discusses their testing of ignitions with aluminum using a laser igniter to vary the energy input, with a comparison of pressures and flow rates. The fifth paper, submitted by the Belarus National Academy of Sciences, examined iron particle contamination within a system and demonstrated how little energy was required to ignite these iron particles using only rapid pressurization as the ignition source.

The third group of papers consists of two manuscripts related to the specific hazards that exist with the oxygen mixture breathed by divers in the scuba industry. The first, submitted by Gentoo Divers International of Switzerland, evaluated the issue of unsafe conditions in scuba diving because a few of the suppliers of scuba equipment are making material changes without realizing the dangers that the high pressure mixture of oxygen and nitrogen pose, and that these should be treated as oxygen systems instead of air systems. The other paper, submitted by the BAM Federal Institute for Materials Research and Testing in Germany, discusses the dangers of allowing only visual inspection for any detrimental effects that testing may have presented on scuba equipment seal materials.

The fourth group consists of four papers that discuss issues related to oxygen system level safety. The first, submitted by NASA White Sands Test Facility, investigates the factors influencing the fire hazards in commercially pure titanium, focusing on the effects of oxygen concentration and specimen diameter. The second, submitted by Air Liquide Corporation of France, investigates the special hazards involved with flowing oxygen gas and a hollow material, especially focusing on how much more severely this configuration burns when compared to a standard solid test specimen in a stagnant atmosphere. The third paper, submitted by Oxycheck Pty Ltd of Australia, investigates the benefits of building hardware by situational non-flammability of the components, a condition where a component is built using only nonflammable materials. The fourth, submitted by Queensland University of Technology in Australia, investigates the special hazards presented by the combustion products that are given off by materials burning in an oxygen fire.

The fifth group consists of two papers that cover issues related to oxygen safety in breathing systems. Both of these papers were submitted by Wendell Hull and Associates. The first compares the hazards present when using halogenated versus non-halogenated polymers as seals for breathing systems, and the concerns presented by toxic combustion products. The second details taking a risk assessment approach to determining the safety of a breathing system, and the successful technique for this assessment.

The last manuscript, submitted by Wendell Hull and Associates, provides detailed investigations and discussions related to the burn curves that have been generated for metals that are burning in a standard test fixture.

The thirteenth volume of *Flammability and Sensitivity of Materials in Oxygen-Enriched Atmospheres* provides a diverse source of new information to air separation industries, oxygen manufacturers, manufacturers of components for oxygen and other industrial gases service, manufacturers of materials intended for oxygen service, and users of oxygen and oxygen-enriched atmospheres, including aerospace, medical, industrial gases, chemical processing, steel and metals refining, as well as to military, commercial or recreational diving.

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