Standard Test Method for Ignition Sensitivity of Nonmetallic Materials and Components by Gaseous Fluid Impact[1]

This standard is issued under the fixed designation G74; the number immediately following the designation indicates the year of original adoption or, in the case of revision, the year of last revision. A number in parentheses indicates the year of last reapproval. A superscript epsilon (ε) indicates an editorial change since the last revision or reapproval.

1. Scope

1.1 This test method describes a method to determine the relative sensitivity of nonmetallic materials (including plastics, elastomers, coatings, etc.) and components (including valves, regulators flexible hoses, etc.) to dynamic pressure impacts by gases such as oxygen, air, or blends of gases containing oxygen.

1.2 This test method describes the test apparatus and test procedures employed in the evaluation of materials and components for use in gases under dynamic pressure operating conditions up to gauge pressures of 69 MPa and at elevated temperatures.

1.3 This test method is primarily a test method for ranking of materials and qualifying components for use in gaseous oxygen. The material test method is not necessarily valid for determination of the sensitivity of the materials in an "as-used" configuration since the material sensitivity can be altered because of changes in material configuration, usage, and service conditions/interactions. However, the component testing method outlined herein can be valid for determination of the sensitivity of components under service conditions. The current provisions of this method were based on the testing of components having an inlet diameter (ID bore) less than or equal to 14 mm (see Note 1).

1.4 A 5 mm Gaseous Fluid Impact Sensitivity (GFIS) test system and a 14 mm GFIS test system are described in this standard. The 5 mm GFIS system is utilized for materials and components that are directly attached to a high-pressure source and have minimal volume between the material/component and the pressure source. The 14 mm GFIS system is utilized for materials and components that are attached to a high pressure source through a manifold or other higher volume or larger sized connection. Other sizes than these may be utilized but no attempt has been made to characterize the thermal profiles of other volumes and geometries (see Note 1).

NOTE 1—The energy delivered by this test method is dependent on the gas volume being rapidly compressed at the inlet to the test specimen or test article. Therefore the geometry of the upstream volume (diameter and length) is crucial to the test and crucial to the application of the results to actual service conditions. It is therefore recommended that caution be exercised in applying the results of this testing to rapid pressurization of volumes larger than those standardized by this test method. This energy delivered by this standard is based on the rapid compression of the volume in either a 5 mm ID by 1000 mm long impact tube or a 14 mm ID by 750 mm long impact tube. These two upstream volumes are specified in this standard based on historic application within the industry.

1.5 This test method can be utilized to provide batch-to-batch comparison screening of materials when the data is analyzed according to the methods described herein. Acceptability of any material by this test method may be based on its 50 % reaction pressure or its probability of ignition based on a logistic regression analysis of the data (described herein).

1.6 Many ASTM, CGA, and ISO test standards require ignition testing of materials and components by gaseous fluid impact, also referred to as adiabatic compression testing. This test method provides the test system requirements consistent with the requirements of these other various standards. The pass/fail acceptance criteria may be provided within other standards and users should refer to those standards. Pass/fail guidance is provided in this standard such as that noted in section 4.6. This test method is designed to ensure that consistent gaseous fluid impact tests are conducted in different laboratories.

1.7 The criteria used for the acceptance, retest, and rejection, or any combination thereof of materials and components for any given application shall be determined by the user and are not fixed by this method. However, it is recommended that at a minimum the 95 % confidence interval be established for all test results since ignition by this method is inherently probabilistic and should be treated by appropriate statistical methods.

1.8 The values stated in SI units are to be regarded as standard. No other units of measurement are included in this standard.

[1] This test method is under the jurisdiction of ASTM Committee G04 on Compatibility and Sensitivity of Materials in Oxygen Enriched Atmospheres and is the direct responsibility of Subcommittee G04.01 on Test Methods.

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1.9 *This standard does not purport to address all of the safety concerns, if any, associated with its use. It is the responsibility of the user of this standard to establish appropriate safety and health practices and determine the applicability of regulatory limitations prior to use.* For specific precautions see Section 7.

2. Referenced Documents

2.1 *ASTM Standards:*[2]

D618 Practice for Conditioning Plastics for Testing

D2463 Test Method for Drop Impact Resistance of Blow-Molded Thermoplastic Containers

D3182 Practice for Rubber—Materials, Equipment, and Procedures for Mixing Standard Compounds and Preparing Standard Vulcanized Sheets

D3183 Practice for Rubber—Preparation of Pieces for Test Purposes from Products

D4894 Specification for Polytetrafluoroethylene (PTFE) Granular Molding and Ram Extrusion Materials

G14 Test Method for Impact Resistance of Pipeline Coatings (Falling Weight Test)

G63 Guide for Evaluating Nonmetallic Materials for Oxygen Service

G88 Guide for Designing Systems for Oxygen Service

G93 Practice for Cleaning Methods and Cleanliness Levels for Material and Equipment Used in Oxygen-Enriched Environments

G94 Guide for Evaluating Metals for Oxygen Service

G128 Guide for Control of Hazards and Risks in Oxygen Enriched Systems

G175 Test Method for Evaluating the Ignition Sensitivity and Fault Tolerance of Oxygen Pressure Regulators Used for Medical and Emergency Applications

MNL 36 Safe Use of Oxygen and Oxygen Systems: Guidelines for Oxygen System Design, Materials Selection, Operations, Storage, and Transportation

2.2 *Military Standards:*[3]

MIL-STD-1330D Standard Practice for precision Cleaning and Testing of Shipboard Oxygen, Helium, Helium-Oxygen, Nitrogen, and Hydrogen Systems

MIL-STD-1622 Cleaning Shipboard Compressed Air Systems

MIL-D-16791G Detergents, General Purpose (Liquid, Nonionic) (26 Jan 1990)

MIL-O-27210E Amendment 1—Oxygen, Aviator's Breathing, Liquid and Gas

2.3 *CGA Standards:*[4]

CGA V-9 Compressed Gas Association Standard for Compressed Gas Cylinder Valves

2.4 *ISO Standards:*[5]

ISO 291 Plastics—Standard Atmospheres for Conditioning and Testing

ISO 10297 Transportable gas cylinders—Cylinder valves—Specification and type testing

ISO 10524-1 Pressure regulators for use with medical gases—Part 1: Pressure regulators and pressure regulators with flow-metering devices

ISO 10524-2 Pressure regulators for use with medical gases—Part 2: Manifold and line pressure regulators

ISO 10524-3 Pressure regulators for use with medical gases—Part 3: Pressure regulators integrated with cylinder valves

ISO 14113 Gas welding equipment—Rubber and plastics hose and hose assemblies for use with industrial gases up to 450 bar (45 MPa)

ISO 15001 Anesthetic and Respiratory Equipment—Compatibility with Oxygen

ISO 23529 Rubber—General procedures for preparing and conditioning test pieces for physical test methods reference

2.5 *IEST Standards:*[6]

IEST-STD-CC1246D "Product Cleanliness Levels and Contamination Control Program," Clean Rooms, August 2005

3. Summary of Method

3.1 The gaseous impact test system exposes material specimens or components/elements to high-velocity (dynamic) gaseous impact environments. The basic configuration consists of a high-pressure accumulator, a high-speed pressurization (impact) valve, test system pressurization lines, test reaction chamber/fixture (for materials tests), test chamber purge and vent systems, and a valve sequencer/control device for automatic control. Fig. 1 depicts a schematic of a typical 5 mm and 14 mm GFIS test system. Fig. 2a and b depict schematics of the typical reaction chambers used for material screening for this testing. Once a material test sample is installed in the reaction chamber, the assembly is attached to the test article interface. Components to be qualified are attached directly to the test article interface.

3.2 The general test procedure is to prepare the test material or component, record significant pretest data, pressurize the system accumulators to the test pressure, calibrate the pressure rise time, and place the test material in the reaction chamber or install the component on the system interface. The test material or component is then subjected to sequential gaseous impacts by alternately opening and closing the test chamber pressurization (impact) and vent valves. The test data obtained shall include test chamber pressures and temperatures, test chamber pressure rise times, pressurization and vent valve actuation times, test gas temperature and pressure, and cycle-to-cycle sequence times. The test material or component is then

[2] For referenced ASTM standards, visit the ASTM website, www.astm.org, or contact ASTM Customer Service at service@astm.org. For *Annual Book of ASTM Standards* volume information, refer to the standard's Document Summary page on the ASTM website.

[3] Available from Standardization Documents Order Desk, DODSSP, Bldg. 4, Section D, 700 Robbins Ave., Philadelphia, PA 19111-5098, http://dodssp.daps.dla.mil.

[4] Available from Compressed Gas Association (CGA), 4221 Walney Rd., 5th Floor, Chantilly, VA 20151-2923, http://www.cganet.com.

[5] Available from International Organization for Standardization (ISO), 1, ch. de la Voie-Creuse, CP 56, CH-1211 Geneva 20, Switzerland, http://www.iso.org.

[6] Available from Institute of Environmental Sciences and Technology (IEST), Arlington Place One, 2340 S. Arlington Heights Rd., Suite 100, Arlington Heights, IL 60005-4516, http://www.iest.org.

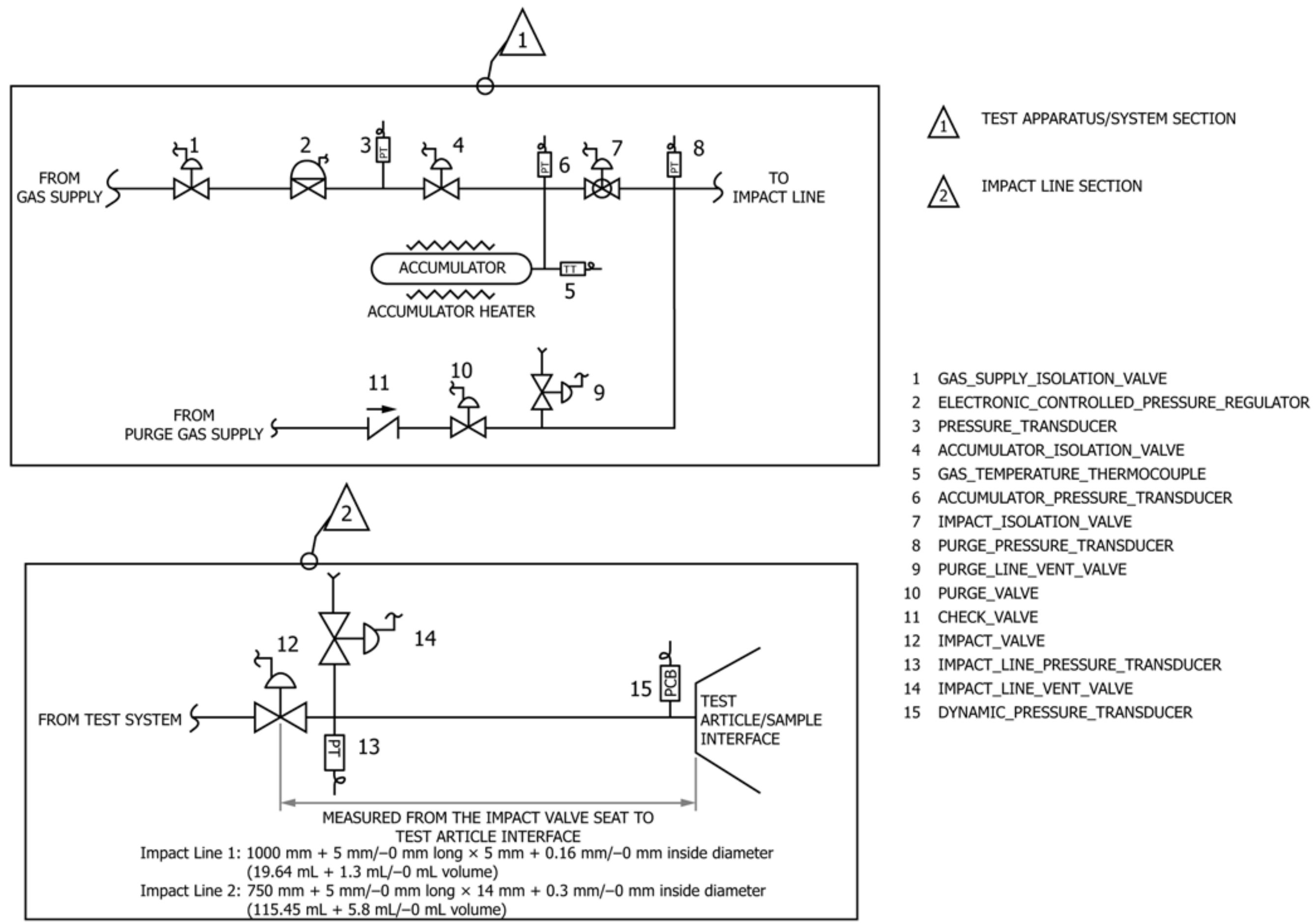

FIG. 1 Gaseous Fluid Impact Test System