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Standard Terminology Relating to the Compatibility and Sensitivity of Materials in Oxygen Enriched Atmospheres[1]

This standard is issued under the fixed designation G126; 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 terminology defines terms related to the compatibility and sensitivity of materials in oxygen enriched atmospheres. It includes those standards under the jurisdiction of ASTM Committee G04.

1.2 The terminology concentrates on terms commonly encountered in and specific to practices and methods used to evaluate the compatibility and sensitivity of materials in oxygen. This evaluation is usually performed in a laboratory environment, and this terminology does not attempt to include laboratory terms.

1.3 *This international standard was developed in accordance with internationally recognized principles on standardization established in the Decision on Principles for the Development of International Standards, Guides and Recommendations issued by the World Trade Organization Technical Barriers to Trade (TBT) Committee.*

2. Referenced Documents

2.1 *ASTM Standards:*[2]

D2863 Test Method for Measuring the Minimum Oxygen Concentration to Support Candle-Like Combustion of Plastics (Oxygen Index)

G63 Guide for Evaluating Nonmetallic Materials for Oxygen Service

G72 Test Method for Autogenous Ignition Temperature of Liquids and Solids in a High-Pressure Oxygen-Enriched Environment

G74 Test Method for Ignition Sensitivity of Nonmetallic Materials and Components by Gaseous Fluid Impact

G86 Test Method for Determining Ignition Sensitivity of Materials to Mechanical Impact in Ambient Liquid Oxygen and Pressurized Liquid and Gaseous Oxygen Environments

G88 Guide for Designing Systems for Oxygen Service

G93 Guide for Cleanliness Levels and Cleaning Methods for Materials and Equipment Used in Oxygen-Enriched Environments

G94 Guide for Evaluating Metals for Oxygen Service

G114 Practices for Evaluating the Age Resistance of Polymeric Materials Used in Oxygen Service

G120 Practice for Determination of Soluble Residual Contamination by Soxhlet Extraction

G121 Practice for Preparation of Contaminated Test Coupons for the Evaluation of Cleaning Agents

G122 Test Method for Evaluating the Effectiveness of Cleaning Agents and Processes

G124 Test Method for Determining the Combustion Behavior of Metallic Materials in Oxygen-Enriched Atmospheres

G125 Test Method for Measuring Liquid and Solid Material Fire Limits in Gaseous Oxidants

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

G131 Practice for Cleaning of Materials and Components by Ultrasonic Techniques

G136 Practice for Determination of Soluble Residual Contaminants in Materials by Ultrasonic Extraction

G144 Test Method for Determination of Residual Contamination of Materials and Components by Total Carbon Analysis Using a High Temperature Combustion Analyzer

G145 Guide for Studying Fire Incidents in Oxygen Systems

3. Terminology

3.1 *Definitions:*

aging, *n*—the exposure of a material to stress, such stress of which may include time, pressure, temperature, abrasion, ionizing radiation, light, impact with gas or particles, tensile or compressive force (either static or cyclic), or any other feature that may be present individually or in combination. **G114**

accelerated aging, *n*—a type of artificial aging whereby the effect of prolonged exposure during service is stimulated by aging at elevated temperature. **G114**

[1] This terminology 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 G04.02 on Recommended Practices.

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[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.

artificial aging, *n*—aging in which a stress variable is outside the domain of exposure that a material might see in a component for oxygen service or in which an alternative mechanism is used to produce an effect that simulates the results of natural aging.

DISCUSSION—The degree of artificiality may vary on a large scale. An example of mild artificiality is exposure of a material to a greater pressure than it experiences in the use condition. An example of extreme artificiality is the use of sandpaper to increase a material's surface roughness to simulate particle-impact abrasion that occurs in the use condition. A high degree of artificiality affects the strength of conclusion that can be drawn, because it may be difficult to relate the results to the use condition. Artificial aging that accelerates natural aging but does not alter the resulting effect is preferred. **G114**

autoignition temperature (AIT), *n*—the lowest temperature at which a material will spontaneously ignite in an oxygen-enriched atmosphere under specific test conditions. **G63, G72, G94, G128**

average regression rate (*Regression Rate of the Melting Interface [RRMI]***),** *n*—the average rate at which the melting interface advances along the test sample length as melting of the test sample occurs. **G124**

blank, *n*—the contamination level of a fluid when the test coupon is omitted.

DISCUSSION—Sometimes referred to as the "background level." **G121**

burn length, *n*—the burn length is the length of the sample that has been consumed by burning.

DISCUSSION—The burn length is determined by subtracting the post-test sample length from the pretest sample length (which does not include the promoter length or the region used by the test sample support). **G124**

characteristic elements, *n*—those factors that must be present for an ignition mechanism to be active in an oxygen-enriched atmosphere. The more characteristic elements present for a particular ignition mechanism, the more active that mechanism is. **G88**

cleaning effectiveness factor (CEF), *n*—the fraction of contaminant removed from an initially contaminated test coupon as determined by gravimetric techniques. **G122**

cleanliness, *n*—the degree to which an oxygen system is free of contaminant.

DISCUSSION—Cleanliness and contamination are opposing properties: increasing cleanliness implies decreasing contamination. **G93**

contaminant (contamination), *n*—unwanted molecular, non-volatile residue (NVR), or particulate matter, or combinations thereof, that could adversely affect or degrade the operation, life, or reliability of the systems or components upon which it resides.

DISCUSSION—Contamination and cleanliness are opposing properties: increasing cleanliness implies decreasing contamination. **G93, G120, G121, G131, G136, G144, G145**

contaminate, *v*—a process of applying contaminant. (non-volatile residue (NVR) and/or particulate matter). **G131, G136, G120, G121**

control coupon (*witness coupon***) ,** *n*—a coupon made from the same material and prepared in exactly the same way as the test coupons which is used to verify the validity of the method or part thereof.

DISCUSSION—In practice, the control coupon is contaminated in the same manner as the test coupons and is subjected to the identical cleaning procedure. **G120, G121, G131**

degas, *v*—the process of removing gases from a liquid. **G131, G136**

direct incident cause, *n*—the mechanical or thermodynamic event (such as breakage of a component or near-adiabatic compression), the physicochemical property (such as heat of combustion), the procedure (such as a valve opening rate), or any departure(s) from the intended state of any of these items, that leads directly to ignition, or fire, or both. **G145**

direct oxygen service, *n*—service in contact with oxygen-enriched atmosphere during normal operations.

DISCUSSION—Examples are oxygen compressor piston rings or control valve seats. **G63, G88, G94**

energy threshold, *n*—the highest impact energy level at a given pressure for which the passing criteria have been met. **G86**

exemption pressure, *n*—the maximum pressure for an engineering alloy at which there are no oxygen velocity restrictions (from CGA 4.4 and EIGA doc IGC13). **G94**

fibers, *n*—particulate matter with a length of 100 µm or greater and a length-to-width ratio of 10 to 1 or greater. **G93**

fire limit, *n*—the threshold limit conditions that will just support self-sustained burning of a material under a combination of specified conditions and at least one variable parameter. (Typically oxidant concentration, diluent nature, pressure, temperature, geometry, flow or flame parameters etc.) **G125**

flammable material, *n*—a material that is able to ignite and demonstrate self-sustained burning per specific test method criteria considering configurational, environmental, and promoter energy conditions (example: Oxidizer%, P, T, etc.).

DISCUSSION—It is noteworthy that a material's flammability in oxygen is highly-dependent on multiple factors (configuration, environment, promoter energy, etc.) and caution is advised to consider these factors when evaluating a material's flammability in a given oxygen application. **G124**

fractional evaporation, *n*—the continuous evaporation of the quantity of liquid that results in a progressive concentration of a less-volatile constituent(s). **G145**

galling, *n*—a condition whereby excessive friction between high spots results in localized welding with subsequent splitting and a further roughening of rubbing surfaces of one or both of two mating parts. **G88**

gaseous fluid impact-igintion resistance, *n*—the resistance of a material to ignition when struck by rapidly compressed high pressure gas in an oxygen enriched atmosphere under a specific test procedure. **G63**

hazard, *n*—source of danger; something that could harm persons or property.

DISCUSSION—The magnitude of a hazard relates to the severity of the harm it could cause. **G128**

highest no-burn pressure, *n*—the highest gas pressure tested (at a specified oxygen concentration and fixed sample temperature) at which a material does not burn more than specific test method criteria. **G124**

highest no-burn temperature, *n*—the maximum sample temperature (at a specified oxygen concentration and pressure) at which a material does not burn more than specific test method criteria. **G124**

igniter, *n*—a material used to ignite the promoter that can burn under an electrical influence, such as a small-diameter wire. **G124**

ignition temperature, *n*—the temperature at which a material will ignite in an oxidant under specific test or system conditions.

DISCUSSION—The ignition temperature of a material in a system is related to the temperature measured by Test Method G72 (AIT), but is also a function of system pressure, configuration and operation, and thermal history of the material. **G88, G128**

ignition mechanisms, *n*—specific factors (physical attributes such as system materials, system design, component design, component performance factors, contamination, etc. as well as system conditions such as temperature, pressure, flow velocities, oxygen concentration, etc.) that cause the initial fire within a system.

DISCUSSION—A system designer must evaluate an oxygen-enriched system for all possible ignition mechanisms. A common ignition mechanism for metals is particle impact. A common ignition mechanism for non-metals is compression heating. **G88, G128**

incident, *n*—an ignition or fire, or both, that is both undesired and unanticipated, or an undesired and unanticipated consequence of an ignition or fire that was anticipated. **G145**

indirect oxygen service, *n*—service that is not normally in contact with oxygen but which might be as a result of a foreseeable malfunction (single fault), operator error, or process upset. Examples: liquid oxygen tank insulation or liquid oxygen pump motor bearings. **G63, G88, G94**

lowest burn pressure, *n*—the minimum tested gas pressure (at a specified oxygen concentration and fixed sample temperature) at which a material burns more than specific test method criteria. **G124**

lowest burn temperature, *n*—the minimum tested sample temperature (at a specified oxygen concentration and pressure) at which a material burns more than specific test method criteria. **G124**

maximum use pressure, *n*—the greatest pressure to which a material can be subjected as a result of a reasonably foreseeable malfunction, operator error or process upset. **G63, G94**

maximum use temperature, *n*—the greatest temperature to which a material can be subjected as a result of a reasonably foreseeable malfunction, operator error, or process upset. **G63, G94**

mechanical impact, *n*—a blow delivered by a plummet that has been dropped from a pre-established height onto a striker pin, in contact with a sample. **G86**

mechanical impact-ignition resistance, *n*—the resistance of a material to ignition when struck by an object in an oxygen-enriched atmosphere under a specific test procedure. **G63, G94, G128**

molecular contaminant (non-particulate contamination), *n*—molecular contaminants that may exist in a gaseous, liquid, or solid state and may be uniformly or nonuniformly disturbed.

DISCUSSION—Molecular contaminant may be found as a solution, an emulsion, or in the form of droplets. Molecular contaminants account for most of what constitutes Non-Volatile Residue (NVR). **G120, G121, G136, G144**

natural aging, *n*—aging in which a material is exposed to conditions replicating those that are present in actual service in a component for oxygen service. **G114**

nonmetal, *n*—any material other than a metal, non-polymeric alloy, or any composite in which the metallic component is not the most easily ignited component and for which the individual constituents cannot be evaluated independently, including ceramics (such as glass), synthetic polymers (such as most rubbers), thermoplastics, thermosets, and natural polymers (such as naturally occurring rubber, wood, and cloth.) **Nonmetallic is the adjective form of this term.** **G63, G93, G94, G128**

nonvolatile residue (NVR), *n*—molecular or particulate matter remaining following the filtration and controlled evaporation of a solvent containing contaminants.

DISCUSSION—The size of a particle is usually defined by its greatest dimension and is specified in micrometers. NVR may be uniformly or non-uniformly distributed as a solution, an emulsion or in the form of droplets. Molecular contaminants account for most of the Non-volatile Residue NVR. **G120, G121, G131, G136, G144**

operating pressure, *n*—the pressure expected under normal operating conditions. **G63, G94**

operating temperature, *n*—the temperature expected under normal operating conditions. **G63, G94**

oxidant compatibility, *n*—the ability of a substance to coexist at an expected pressure and temperature with both an oxidant and a potential source(s) of ignition within a risk parameter acceptable to the user. **G125, G128**

oxidant index, *n*—the minimum concentration of an oxidant, such as oxygen, nitrous oxide, or fluorine, expressed as a volume percent, in a mixture of the oxidant with a diluent, such as nitrogen, helium, or carbon dioxide, that will just support sustained burning of a material initially as given in its specific configuration (width and shape) and at given conditions of temperature, pressure, flow conditions, and propagation direction, etc. (see *oxygen index*).