



Standard Terminology Relating to the Compatibility and Sensitivity of Materials in Oxygen Enriched Atmospheres¹

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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.

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 Materials to 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 Practice for Cleaning Methods and Cleanliness Levels for Material 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
- 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
- G127 Guide for the Selection of Cleaning Agents for Oxygen Systems
- 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:

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

contaminant, *n*—unwanted molecular or particulate matter that could adversely affect or degrade the operation, life, or reliability of the systems or components upon which it resides.

G93, G120, G121, G131, G136, G144

contaminate, *v*—to make unfit for use, either intentionally or unintentionally, by introduction of a contaminant.

G131, G136

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 G04.03 on Terminology.

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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.



contamination, *n*—(1) the amount of unwanted molecular or particulate matter in a system; (2) the process or condition of being contaminated.

DISCUSSION—Contamination and cleanliness are opposing properties: increasing cleanliness implies decreasing contamination.

G93, G120, G121, G131, G136, G144

control coupon (*also witness coupon*), *n*—(1) 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 (**G120, G131**); (2) a coupon made from the same material as the test coupons but in this test method is not coated with the contaminant (**G121**).

DISCUSSION—(1) in this practice, the control coupon is contaminated in the same manner as the test coupons and is subjected to the identical extraction procedure (**G120**); (2) in this practice, the control coupon is contaminated in the same manner as the test coupons and is subjected to the identical cleaning procedure (**G131**).

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

direct oxygen service, *n*—service in contact with oxygen-enriched atmosphere during normal operations. **G63, G88, G94**

DISCUSSION—Examples are oxygen compressor piston rings or control valve seats.

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

indirect oxygen service, *n*—service in which oxygen is not normally but may be contacted as a result of an operator error, or process disturbance, such as liquid oxygen tank insulation or liquid oxygen pump motor bearings. **G63, G88, G94**

DISCUSSION—Examples include, liquid oxygen tank insulation or liquid oxygen pump motor bearings.

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 disturbance. **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 disturbance. **G63, G94**

molecular contaminant, *n*—nonparticulate contaminant that may exist in either a gaseous, liquid, or solid state.

DISCUSSION—Molecular contaminant may be uniformly or nonuniformly distributed as a solution or an emulsion or may be in the form of droplets. Molecular contaminants account for most of what constitutes nonvolatile residue.

G120, G121, G136, G144

nonmetal, *n*—any material other than a metal, nonpolymeric 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, and 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 liquid containing contaminants.

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**

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

G93, G125, G128, G145

oxygen-enriched, *adj*—containing more than 25 mole percent oxygen. **G63, G88, G94, G128, G145**

DISCUSSION—Other standards such as those published by NFPA and OSHA differ from the definition in their specification of oxygen concentration.

particle (*particulate contaminant*), *n*—a piece of matter in a solid state with observable length, width, and thickness.

DISCUSSION—The size of a particle is usually defined by its greatest dimension and is specified in micrometers.

G120, G121, G131, G136, G144

qualified technical personnel, *n*—persons such as engineers and chemists who, by virtue of education, training, or experience, know how to apply physical and chemical principles involved in the reactions between oxidants and other materials. **G63, G88, G94, G128, G145**

reaction effect, *n*—the personnel injury, facility damage, product loss, downtime, or mission loss that could occur as the result of an oxygen fire. **G63, G94**

surface roughness, **R_a**, *n*—the arithmetic average deviation of the surface profile from the centerline, normally reported in micrometers. **G121, G122**

3.2 Definitions of Terms Specific to This Standard:

aging, *n*—the exposure of a material to individual or combined stresses such as time, temperature, pressure, abrasion, ionizing radiation, light, impact with gas or particles, tensile or compressive force (either static or cyclic), contact with other materials or chemicals, or any other feature that may be present during a material's service life. **G114**

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**

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**

average regression rate (apparent burn rate), *n*—the average rate at which the burning/solid-metal interface advances along the test sample length. **G124**

blank, *n*—the contamination level, sometimes referred to as the background level, of a fluid when the test coupon is omitted. **G121**

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**

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

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 an incident (see *incident*). **G145**

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 sustained combustion of a material under a combination of specified conditions and at least one variable parameter. **G125**

DISCUSSION—Examples are; oxidant concentration, diluent nature, pressure, temperature, geometry, and flow.

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

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**

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

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

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**

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 combustion of a material initially at given conditions of temperature, pressure, flow conditions, and propagation direction (see *oxygen index*).

DISCUSSION—The oxidant index (or limit) may be more specifically identified by naming the oxidant, such as oxygen index (or limit), nitrous oxide index (or limit), or fluorine index (or limit). Unless specified otherwise, the typical oxidant is oxygen, the typical diluent is nitrogen, and the typical temperature is ambient. **G125**

oxygen index, *n*—the minimum concentration of oxygen, expressed as a volume percent, in a mixture of oxygen and nitrogen that will just support sustained combustion of a material initially at room temperature under the conditions of Test Method D2863 (see Test Method D2863). **G125**

particulate, *n*—a general term used to describe a finely divided solid of organic or inorganic matter. **G93**

pressure limit, *n*—the minimum pressure of an oxidant (or oxidant mixture) that will just support sustained combustion of a material initially at given conditions of oxidant concentration, temperature, flow condition, and propagation direction.

DISCUSSION—The pressure limit may be more specifically identified by naming the oxidant: oxygen pressure limit, nitrous oxide pressure limit, or fluorine pressure limit. **G125**

promoter, *n*—a material that provides thermal energy which is used to increase the temperature to start combustion of the material being tested. **G124**

residual contamination, *R_c*, *n*—the absolute mass of contaminant remaining after a cleaning process, expressed in milligrams per square centimeter of area or optionally as milligrams per square metre. **G122**

risk, *n*—probability of loss or injury from a hazard.

DISCUSSION—The magnitude of a risk relates to how likely a hazard is to cause harm. **G128**

self-sustained combustion, *n*—combustion that consumes a sample to the point at which the sample holder affects further combustion, assuming sufficient oxidizer. **G124**

temperature limit, *n*—the minimum temperature of an oxidant (or oxidant mixture) that will just support sustained combustion of a material initially at given conditions of oxidant concentration, temperature, pressure, flow condition, and propagation direction.

DISCUSSION—The temperature limit may be more specifically identified by naming the oxidant: oxygen temperature limit, nitrous oxide temperature limit, or fluorine temperature limit. **G125**

threshold pressure, *n*—the minimum gas pressure (at a specified oxygen concentration and ambient temperature) that supports self-sustained combustion of the entire standard sample. **G124**



4. Symbols

R_c = residual contamination

R_a = surface roughness

5. Acronyms

CEF = cleaning effectiveness factor

AIT = autogenous ignition temperature or autoignition temperature

NVR = nonvolatile residue

6. Keywords

6.1 atmospheres; definitions; material compatibility; material sensitivity; oxygen-enriched; terminology

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