



Designation: G 114 – 98

Standard Practice for Aging Oxygen-Service Materials Prior to Ignitibility or Flammability Testing¹

This standard is issued under the fixed designation G 114; 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 practice covers methods to determine the influence of time and stress on a material's oxygen compatibility.

1.2 This practice addresses both methods that have a foundation of experience and potential methods that have yet to be verified for validity. The latter are included to promote research and later elaboration in this practice as methods of the former type.

1.3 The values stated in SI units are to be regarded as the standard, however, all numerical values must also be cited in the systems in which they were actually measured.

1.4 *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. Specific precautionary statements are given in Section 9.*

2. Referenced Documents

2.1 ASTM Standards:

D 4809 Test Method for Heat of Combustion of Liquid Hydrocarbon Fuels by Bomb Calorimeter (Intermediate Precision Method)²

G 72 Test Method for Autogenous Ignition Temperature of Liquids and Solids in a High-Pressure Oxygen-Enriched Environment³

G 74 Test Method for Ignition Sensitivity of Materials to Gaseous Fluid Impact³

G 86 Test Method for Determining Ignition Sensitivity of Materials to Mechanical Impact in Pressurized Oxygen Environments³

G 125 Test Method for Measuring Liquid and Solid Material Fire Limits in Gaseous Oxidants³

2.2 Federal Standard:

Federal Specification BB-0-925 Oxygen, Technical, Gas and Liquid⁴

3. Terminology

3.1 Definitions of Terms Specific to This Standard:

3.1.1 *aging*—the exposure of a material to stress, such stress of which may include time, pressure, contact with materials or chemicals, 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 during a material's service life. These stressors may be present individually or in combination.

3.1.2 *artificial aging*—aging in which a stress variable is outside the domain of exposure that the 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. The degree of artificiality may vary on a large scale. An example of mild artificiality might be exposure of a material to a greater pressure than it experiences in the use conditions. An example of extreme artificiality would be the use of sand paper 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 is preferred that accelerates natural aging but does not alter it.

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

4. Summary of Practice

4.1 This practice allows a systematic evaluation of the influence of age and use on a material's oxygen compatibility. To apply its principle, the user first characterizes the material of interest, then subjects the material to an aging stressor, and recharacterizes the material. The effect of the aging is then reported as positive or negative depending upon whether the material's compatibility is improved or degraded, and the

¹ This guide is under the jurisdiction of ASTM Committee G-4 on Compatibility and Sensitivity of Materials in Oxygen Enriched Atmospheres and is the direct responsibility of Subcommittee G04.02 on Recommended Practices.

Current edition approved Sept. 10, 1998. Published February 1999. Originally published as G 114 – 93. Last previous edition G 114 – 93.

² *Annual Book of ASTM Standards*, Vol 05.03.

³ *Annual Book of ASTM Standards*, Vol 14.03.

⁴ Available from Standardization Documents Order Desk, Bldg. 4 Section D, 700 Robbins Ave., Philadelphia, PA 19111.



measure of the influence is reported as the degree to which the measured properties changed. In incident studies, in which initial characterization data are not available, then historical or average-property data may be used to draw somewhat coarser conclusions.

4.2 This practice describes a rationale for selecting aging procedures and relating them to key fire properties. Most of the possible studies have not been verified for significance. However, one general procedure that involves aging at pressure and temperature has been used and found to yield meaningful results, and it is described in specific detail as an example. As data become available to validate other specific meaningful aging procedures, they too will be included as examples.

5. Significance and Use

5.1 A material's fire resistance is a crucial material selection property. However, after a period of service, the material may metamorphosize into something quite different than that which it was when new. For example, all materials for oxygen service should have good mechanical properties, because mechanical failure often leads to ignition and fire damage. Therefore, any mechanism that may compromise a material's mechanical properties can invalidate it for use.

5.2 This practice allows the user to gain insight into the effects of aging on the materials in a system.

6. Apparatus

6.1 The apparatus used to age materials can vary greatly. This practice will focus on small-scale aging methods involving only a few specimens at most. The scale of the aging procedure can be increased in numerous ways, provided care is taken to ensure safety. When possible, the apparatus used to perform the fire test may also serve as a vehicle for the aging step, and that is the premise that will be discussed here.

6.2 An example of an aging procedure might be to insert a specimen into the autogenous ignition test vessel of Test Method G 72 and to both pressurize it and warm it to preselected soak levels for an aging cycle. In this case, the apparatus is the same as in Test Method G 72.

6.3 Aging related to gaseous impact might involve placing the specimen in the Test Method G 74 apparatus and soaking it at pressure (or elevated temperatures the apparatus, or both, is able to safely contain). In this case, the apparatus is that of Test Method G 74.

6.4 Specimen preparation for larger scale experiments or unique combinations of stressors that qualify as research may utilize other hardware that allows safe aging. Safety *must* be carefully evaluated for any aging arrangement.

7. Rationale for Aging Tests

7.1 This practice addresses methods to age materials so that aging effects on fire properties may be assessed using standard fire-test methods.

7.2 The body of information for aging influences is small, and so, this practice is intended to encourage such testing as a part of its goal of proposing methods to age and analyze the materials. In principle, for an aging test to be meaningful and

useful, it must demonstrate an ability to discern at least some significant changes in at least some materials as a result of aging.

7.3 Aging of specimens can potentially result in numerous changes to the material. Aging may modify the surface of a specimen; exposure to ozone, light, or mechanical wear can increase the surface area through the development of cracks (crazing) or erosion. Chemical exposure may result in etching of a surface. Aging may alter the chemistry of a material; oxides may form or molecular chains may be broken. Aging may introduce free oxygen into the structure of a material; diffusion may lead to oxygen molecules permeating the material structure and entering pores that may be present in the material.

7.4 Some changes resulting from aging may alter a material's fire properties, including its ignition and propagation tendencies. In some cases, aging may render a material less susceptible to fire, while others may make it more susceptible to fire. Hence, aging tests may be used to evaluate whether a material may become unacceptable in time or whether it can be conditioned (artificially aged) as a means to improve its long-term properties. For example, temperature aging may drive off volatile materials that can compromise ignition temperature, without necessarily destroying mechanical properties and render batch testing less necessary.

7.5 In general, aging is expected to have a greater influence on a material's ignition properties than its propagation properties. To date, the only background on aging influences is that of the Bundesanstalt Für Materialforschung und -Prüfung (BAM) which has for years assessed the effect on a material's autogenous ignition temperature of aging it at elevated pressure and temperature. BAM has used the results of the testing to establish maximum constraints on the use of materials at elevated pressure and temperature.⁵

8. Reagents and Materials

8.1 *Oxygen*—Typically oxygen conforming to Federal Specification BB-0-925, Type I or oxygen of 99.5 % minimum purity is used. Oxygen of other purities or in mixture with other materials may be necessary depending upon the intent of the study.

8.2 A wide range of reagents and materials may find application in the use of this practice. For example, solvent exposure of an elastomer may represent a stressor that requires study. It is not practical to itemize such materials in this practice, as they are associated with normal or upset use conditions. Therefore, the identification of such solvents must rest with the user of this practice.

9. Safety Precautions

9.1 Oxygen

NOTE 1—**Warning:** Oxygen vigorously accelerates combustion.

Keep oil and grease away. Do not use oil or grease on regulators, gages

⁵ Wegener, W., Binder, C., Hengstenberg, P., Herrmann, K. P., and Weinert, P., "Tests to Evaluate the Suitability of Materials for Oxygen Service," *Flammability and Sensitivity of Materials in Oxygen-Enriched Atmospheres: Third Volume*, ASTM STP 986, D. W. Schroll, Ed. ASTM, 1988, pp. 268–278.