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Standard Guide for the Selection of Cleaning Agents for Oxygen-Enriched Systems¹

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1. Scope

1.1 The purpose of this guide is to establish a procedure to select cleaning agents, both solvents and water-based detergents, for oxygen-enriched systems. This includes laboratory-scale tests for cleaning effectiveness, materials compatibility, and oxygen compatibility.

1.2 The effectiveness of a particular cleaning agent depends upon the method by which it is used, the nature and type of the contaminants, and the characteristics of the article being cleaned, such as size, shape, and material. Final evaluation of the cleaning agent should include testing of actual products and production processes.

1.3 Different cleaning agents may be required for different cleaning activities, such as aqueous ultrasonic cleaning, spray cleaning, hand wiping, and flushing of oxygen lines in field applications.

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, health, and environmental practices and determine the applicability of regulatory limitations prior to use.*

1.5 *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

D471 Test Method for Rubber Property—Effect of Liquids
D543 Practices for Evaluating the Resistance of Plastics to Chemical Reagents

¹ This guide 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.

D1193 Specification for Reagent Water

D1460 Test Method for Rubber Property—Change in Length During Liquid Immersion

D2512 Test Method for Compatibility of Materials with Liquid Oxygen (Impact Sensitivity Threshold and Pass-Fail Techniques)

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

D4809 Test Method for Heat of Combustion of Liquid Hydrocarbon Fuels by Bomb Calorimeter (Precision Method)

F483 Practice for Total Immersion Corrosion Test for Aircraft Maintenance Chemicals

G5 Reference Test Method for Making Potentiodynamic Anodic Polarization Measurements

G31 Guide for Laboratory Immersion Corrosion Testing of Metals

G59 Test Method for Conducting Potentiodynamic Polarization Resistance Measurements

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

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

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

2.2 CGA Document:

CGA Pamphlet G-4.1 Cleaning Equipment for Oxygen Service

2.3 Other ASTM Documents:

MNL36 Safe Use of Oxygen and Oxygen Systems: Handbook for Design, Operation, and Maintenance²

3. Significance and Use

3.1 The purpose of this guide is to provide information that may be considered when selecting and qualifying a cleaning agent for oxygen-enriched systems.

3.2 Insufficient cleanliness can result in the ignition of contaminants or components by a variety of mechanisms. Therefore, an acceptable level of contamination for each condition of use in oxygen-enriched service should be defined. The acceptable level of contamination may depend on various factors, such as:

- 3.2.1 The nature and type of the contaminants,
- 3.2.2 The location and degree of contamination,
- 3.2.3 The type of substrate material,
- 3.2.4 The configuration and end use of the equipment or part to be cleaned, and
- 3.2.5 The operating parameters of the oxygen-enriched system (pressure, temperature, phase, concentration, fluid velocity, etc.).

4. Selection of Cleaning Agent

4.1 Before a specific cleaning agent is selected for testing, the following attributes should be considered.

- 4.1.1 Toxicity,
- 4.1.2 Carcinogenicity,
- 4.1.3 Stability and recyclability,
- 4.1.4 Waste disposal,
- 4.1.5 Environmental impacts and associated regulatory restrictions (ozone depletion potential, global warming potential, volatile organic compound contribution to ground level ozone, etc.),
- 4.1.6 Inertness (flammability and combustibility),
- 4.1.7 Corrosivity and compatibility with metallic and non-metallic engineering materials,
- 4.1.8 Availability and technical support from supplier,
- 4.1.9 Cost effectiveness, and
- 4.1.10 Compliance with local, state and federal regulations.

4.2 It is desirable that the cleaning agent could be applied by a variety of methods, such as wiping, immersion, spraying, etc. Consequently, the cleaning agent manufacturer's instructions for applying the cleaner should be considered.

5. Selection of Substrate Materials

5.1 Substrate materials used for cleaning effectiveness and compatibility tests should be representative of those used in the end application, including both the parts to be cleaned and the cleaning system itself.

5.2 Metallic Materials:

5.2.1 Metallic materials commonly used in oxygen-enriched systems are listed in Guide **G94** and Handbook **MNL36**.

5.2.2 Materials compatibility tests should include those metals used in the oxygen-enriched system that are expected to come in contact with the candidate cleaning agent. As a minimum, alloys representative of each family of metals used

in the system should be tested. The alloy and finish expected to be used in the oxygen-enriched system that is most susceptible to corrosion within the metal family should be tested.

5.3 Nonmetallic Materials:

5.3.1 Nonmetallic materials commonly used in oxygen-enriched systems are discussed in Guide **G63** and Handbook **MNL36**.

5.3.2 Materials compatibility tests should include those nonmetallic materials used in the oxygen-enriched system that are expected to come in contact with the candidate cleaning agent. As a minimum, materials representative of each family of these nonmetals should be tested.

6. Cleaning Effectiveness Tests

6.1 Selection of Test Contaminants:

6.1.1 Numerous contaminants encountered in oxygen-enriched systems that could result from manufacturing, assembly, fabrication, and construction processes are listed in Practice **G93**. Typical contaminant types include:

- 6.1.1.1 Hydrocarbon oils and greases (mineral oil, hydraulic fluids, lubricants, water-displacing compounds),
- 6.1.1.2 Fluorinated fluids and greases,
- 6.1.1.3 Inks,
- 6.1.1.4 Machine cutting oils (hydrocarbon- or water-based),
- 6.1.1.5 Carbon deposits,
- 6.1.1.6 Silicone oils and greases,
- 6.1.1.7 Phosphate esters (fire-resistant hydraulic fluids),
- 6.1.1.8 Waxes,
- 6.1.1.9 Dye penetrants,
- 6.1.1.10 Chlorotrifluoroethylene based oils and greases,
- 6.1.1.11 Pariculate (sand, metal shavings, fibers, etc.), and
- 6.1.1.12 Tape residue.

NOTE 1—Some contaminants are more difficult to remove after aging or exposure to heat. Selection of a cleaning agent should consider removal efficiency for both the type and condition of contaminants typically encountered at the facility.

6.1.2 Among typical contaminants, hydrocarbons are the prime candidates for the test protocol. When dealing with other contaminants, the user should attempt to classify the type of contamination expected on the equipment to be cleaned.

6.1.3 As a preliminary test, mineral oil or a mixture of common cutting oils may be used as a contaminant. It may be carried in a suitable volatile solvent as a means to introduce it into a system. In addition, vacuum pump oil, or a compressor oil are suggested as contaminants for the evaluation program. In a more refined test at later stages, fluorinated oils/greases, dye penetrants, or a mixture of as many contaminants as necessary may be prepared in a suitable solvent. Eventually, actual contaminants encountered on an engineering component or system for oxygen-enriched service should be evaluated for removal efficiency.

6.2 Test Methods:

6.2.1 A suggested starting level of contamination is 1000 mg/m². This is a hydrocarbon level that is consistent with contamination levels associated with final cleaning and it is twice the acceptable level specified for oxygen service in CGA pamphlet G-4.1. Heavily contaminated surfaces with levels in