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Standard Guide for Microbial Contamination and Biodeterioration in Turbine Oils and Turbine Oil Systems¹

This standard is issued under the fixed designation D8506; 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 guide provides personnel who have a limited microbiological background with an understanding of the symptoms, occurrence, and consequences of chronic microbial contamination. The guide also suggests means for detection and control of microbial contamination in turbine oils and turbine oil systems. This guide applies primarily to turbine lubricants (see Specifications [D4293](#) and [D4304](#)) and turbine oil systems. However, the principles discussed herein also apply generally to lubricating oils with viscosities $<100 \text{ mm}^2/\text{s}$ (for example, see Specification [D6158](#)).

1.2 This guide focuses on turbine system and turbine oil microbiology. Despite considerable differences in turbine systems (for example, gas and steam driven turbines; power generation and propulsion; etc.) as ecosystems for microbial communities – with the exception of temperature – these differences are largely irrelevant. Ambient temperatures are typically similar. Recirculating turbine oil temperatures are commonly $>40^\circ\text{C}$. However, generally speaking, all systems in which accumulations of free water can develop, share properties that are considered in this guide.

1.2.1 Steam turbines, and to a greater extent hydro turbines, are continuously exposed to water ingress. Diligence is needed to ensure seals and bearings are in good condition to prevent water ingress or conditions that are conducive to biodeterioration. However, due to the risk of the accumulation of condensation, all equipment can become susceptible when shut down for extended periods.

1.3 This guide complements Energy Institute's Guidelines on detecting, controlling, and mitigating microbial growth in oils and fuels used at power generation facilities ([2.2](#)). The Energy Institute's guidance document provides greater detail than the overview provided in this guide.

1.4 Microbial contamination in turbine oil systems shares common features with microbial contamination in fuel systems (See Guide [D6469](#)). However, there are also relevant differ-

ences. Although the chemistry of the fluids is different, this Guide draws heavily on [D6469](#) but highlights unique aspects of turbine oil and turbine oil system biodeterioration and microbial contamination.

1.5 This guide is not a compilation of all of the concepts and terminology used by microbiologists. It provides basic explanations of microbial contamination and biodeterioration in turbine oils and turbine oil systems.

1.6 The values in SI units are to be regarded as the standard.

1.7 *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.*

1.8 *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

[D130](#) Test Method for Corrosiveness to Copper from Petroleum Products by Copper Strip Test

[D445](#) Test Method for Kinematic Viscosity of Transparent and Opaque Liquids (and Calculation of Dynamic Viscosity)

[D664](#) Test Method for Acid Number of Petroleum Products by Potentiometric Titration

[D665](#) Test Method for Rust-Preventing Characteristics of Inhibited Mineral Oil in the Presence of Water

[D888](#) Test Methods for Dissolved Oxygen in Water

[D892](#) Test Method for Foaming Characteristics of Lubricating Oils

[D943](#) Test Method for Oxidation Characteristics of Inhibited Mineral Oils

¹ This guide is under the jurisdiction of ASTM Committee [D02](#) on Petroleum Products, Liquid Fuels, and Lubricants and is the direct responsibility of Subcommittee [D02.C0.01](#) on Turbine Oil Monitoring, Problems and Systems.

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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.

- D974** Test Method for Acid and Base Number by Color-Indicator Titration
- D1067** Test Methods for Acidity or Alkalinity of Water
- D1293** Test Methods for pH of Water
- D1331** Test Methods for Surface and Interfacial Tension of Solutions of Paints, Solvents, Solutions of Surface-Active Agents, and Related Materials
- D1401** Test Method for Water Separability of Petroleum Oils and Synthetic Fluids
- D1500** Test Method for ASTM Color of Petroleum Products (ASTM Color Scale)
- D1744** Test Method for Determination of Water in Liquid Petroleum Products by Karl Fischer Reagent (Withdrawn 2016)³
- D1976** Test Method for Elements in Water by Inductively-Coupled Plasma Atomic Emission Spectroscopy
- D2068** Test Method for Determining Filter Blocking Tendency
- D2272** Test Method for Oxidation Stability of Steam Turbine Oils by Rotating Pressure Vessel
- D2273** Test Method for Trace Sediment in Lubricating Oils (Withdrawn 2022)³
- D2896** Test Method for Base Number of Petroleum Products by Potentiometric Perchloric Acid Titration
- D3326** Practice for Preparation of Samples for Identification of Waterborne Oils
- D3328** Test Methods for Comparison of Waterborne Petroleum Oils by Gas Chromatography
- D3339** Test Method for Acid Number of Petroleum Products by Semi-Micro Color Indicator Titration
- D3870** Practice for Establishing Performance Characteristics for Colony Counting Methods in Microbiology (Withdrawn 2000)³
- D4175** Terminology Relating to Petroleum Products, Liquid Fuels, and Lubricants
- D4293** Specification for Phosphate Ester-Based Fluids for Turbine Lubrication and Steam Turbine Electro-Hydraulic Control (EHC) Applications
- D4304** Specification for Mineral and Synthetic Lubricating Oil Used in Steam or Gas Turbines
- D4310** Test Method for Determination of Sludging and Corrosion Tendencies of Inhibited Mineral Oils
- D4378** Practice for In-Service Monitoring of Mineral Turbine Oils for Steam, Gas, and Combined Cycle Turbines
- D4412** Test Methods for Sulfate-Reducing Bacteria in Water and Water-Formed Deposits
- D4454** Test Method for Simultaneous Enumeration of Total and Respiring Bacteria in Aquatic Systems by Microscopy (Withdrawn 2015)³
- D4840** Guide for Sample Chain-of-Custody Procedures
- D4898** Test Method for Insoluble Contamination of Hydraulic Fluids by Gravimetric Analysis
- D5185** Test Method for Multielement Determination of Used and Unused Lubricating Oils and Base Oils by Inductively Coupled Plasma Atomic Emission Spectrometry (ICP-AES)
- D5392** Test Method for Isolation and Enumeration of *Escherichia coli* in Water by the Two-Step Membrane Filter Procedure
- D6158** Specification for Mineral Hydraulic Oils
- D6224** Practice for In-Service Monitoring of Lubricating Oil for Auxiliary Power Plant Equipment
- D6304** Test Method for Determination of Water in Petroleum Products, Lubricating Oils, and Additives by Coulometric Karl Fischer Titration
- D6439** Guide for Cleaning, Flushing, and Purification of Steam, Gas, and Hydroelectric Turbine Lubrication Systems
- D6469** Guide for Microbial Contamination in Fuels and Fuel Systems
- D7155** Practice for Evaluating Compatibility of Mixtures of Turbine Lubricating Oils
- D7464** Practice for Manual Sampling of Liquid Fuels, Associated Materials and Fuel System Components for Microbiological Testing
- D7669** Guide for Practical Lubricant Condition Data Trend Analysis
- D7687** Test Method for Measurement of Cellular Adenosine Triphosphate in Fuel and Fuel-associated Water With Sample Concentration by Filtration
- D7720** Guide for Statistically Evaluating Measurand Alarm Limits when Using Oil Analysis to Monitor Equipment and Oil for Fitness and Contamination
- D7843** Test Method for Measurement of Lubricant Generated Insoluble Color Bodies in In-Service Turbine Oils using Membrane Patch Colorimetry
- D7847** Guide for Interlaboratory Studies for Microbiological Test Methods
- D7978** Test Method for Determination of the Viable Aerobic Microbial Content of Fuels and Associated Water—Thixotropic Gel Culture Method
- D8112** Guide for Obtaining In-Service Samples of Turbine Operation Related Lubricating Fluid
- E177** Practice for Use of the Terms Precision and Bias in ASTM Test Methods
- E1326** Guide for Evaluating Non-culture Microbiological Tests
- E1542** Terminology Relating to Occupational Health and Safety
- E2551** Test Methods for Humidity Calibration (or Conformation) of Humidity Generators for Use with Thermogravimetric Analyzers
- E2756** Terminology Relating to Antimicrobial and Antiviral Agents

2.2 Energy Institute Standards:⁴

- IP 613** Determination of the viable aerobic microbial content of fuels and associated water - Thixotropic Gel Culture Method Guidelines on detecting, controlling, and mitigating microbial growth in oils and fuels used at power generation facilities.

³ The last approved version of this historical standard is referenced on www.astm.org.

⁴ Available from Energy Institute, 61 New Cavendish St., London, WIG 7AR, U.K. <https://publishing.energyinst.org/ip-test-methods>.