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.

Designation: D8544 – 24

Standard Test Method for Determination of Conductive Deposits of Electrical and Mechanical Components from Fluids in Liquid and Vapor States within an Electrically Charged System[1]

This standard is issued under the fixed designation D8544; 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 test method covers the basic operation of the conductive deposit test. The apparatus is utilized to monitor the formation of dendrites and deposits that are conductive and may form under oxidation conditions of fluids used in electric vehicles and other industries where electronics are involved. The oxidation conditions can vary from 80 °C to 180 °C with very specific circuit boards, under power, and monitoring changes in conductance over time. Both the liquid and vapor areas are monitored for this condition over time. Variables in temperature, voltage, and time can be altered according to the industry need. A reported index based on the rate of deposit formation may be implemented. The typical testing is performed at 150 °C over a period of up to 500 h with a monitored voltage applied.

NOTE 1—Testing up to 1000 h has some historical significance and is an option but not covered in this test method.

1.2 This test method has an interim precision. An interlaboratory study of this test method is being conducted and a complete precision statement is expected to be available on or before December 2024.

1.3 The values stated in SI units are to be regarded as standard. No other units of measurement are included in this standard.

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]

D130 Test Method for Corrosiveness to Copper from Petroleum Products by Copper Strip Test

D4057 Practice for Manual Sampling of Petroleum and Petroleum Products

D4175 Terminology Relating to Petroleum Products, Liquid Fuels, and Lubricants

D5185 Test Method for Multielement Determination of Used and Unused Lubricating Oils and Base Oils by Inductively Coupled Plasma Atomic Emission Spectrometry (ICP-AES)

E986 Practice for Scanning Electron Microscope Beam Size Characterization

2.2 *SAE Standard:*[3]

SAE J3200 Fluid for Automotive Electrified Drivetrains

3. Terminology

3.1 *Definitions:*

3.1.1 For definitions of terms used in this test method, refer to Terminology D4175.

3.1.2 *conductive deposits, n—in electric vehicle drivelines and other powered systems*, material adhering to or collecting on electrical components that conduct electricity.

3.1.3 *conductive deposit factor, n*—a value that is used to estimate the amount of conductive deposits being formed over time and is calculated using a log summation of the area between the beginning resistance baseline and the resistance curve formed by the arcing conductive deposit events over time.

[1] This test method is under the jurisdiction of ASTM Committee D02 on Petroleum Products, Liquid Fuels, and Lubricants and is the direct responsibility of Subcommittee D02.09.0G on Oxidation Testing of Engine Oils.

Current edition approved March 1, 2024. Published March 2024. DOI: 10.1520/D8544-24.

[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.

[3] Available from SAE International (SAE), 400 Commonwealth Dr., Warrendale, PA 15096, http://www.sae.org.

Copyright © ASTM International, 100 Barr Harbor Drive, PO Box C700, West Conshohocken, PA 19428-2959. United States

3.1.3.1 *Discussion*—See Appendix X1 for more information.

3.1.4 *continuity loop, n*—on the circuit board there is a circuit board trace made of conductive copper that outlines the outside of the board in the liquid and vapor levels; this is monitored during the test for consistent continuity; should the copper become depleted at any time during the test, any data after the copper is depleted, where the circuit becomes open and non-conductive, the test from that point to the end of the test becomes invalid.

3.1.5 *inductively-coupled plasma (ICP), n*—a high temperature discharge generated by flowing an ionizable gas through a magnetic field induced by a load coil that surrounds the tubes carrying the gas.

3.1.6 *non-conductive deposits, n—in electric vehicle drivelines and other powered systems*, material adhering to or collecting on electrical components that do not conduct electricity.

3.1.7 *scanning electron microscope (SEM), n*—a type of electron microscope that produces images of a sample by scanning the surface with a focused beam of electrons.

4. Summary of Test Method

4.1 A powered circuit board with bare copper traces is placed in a stack with a board with no traces to create tightly controlled gaps and inserted to a lubricant in a test cell and heated to 150 °C. The test cell with the board assembly along with the fluid and vapor above the fluid are enclosed, but not sealed, for a duration of up to 500 h. Other material, temperatures, timeframes, and power requirements may be utilized but were not studied in the precision determined. The conductance between non-contacting traces is measured throughout the duration of the test in both the liquid and vapor areas of the test cell. The overall rate of change indicates a shorting failure caused by the formation of conductive deposits between traces. Meanwhile the current, in a continuous conductive loop on the circuit board, is monitored to ensure that copper has not been corroded so far to create unintended gaps in the traces that would hide shorting failures. Fluids not creating shorting failures or unintended gaps in the traces for the full duration of the test are considered to have good performance. Post analysis, such as elemental analysis by ICP, SEM, visual ratings, or other practices may be conducted on the fluid after test and compared to results from fresh fluid for additional information.

5. Significance and Use

5.1 This method may be utilized to assess the suitability of a fluid for use in electric vehicle drivelines and other powered or corrosive applications to form conductive deposits and corrosion tendencies with copper or other materials. Fluids known to perform poorly in the field have been shown to fail this test and fluids known to perform well in the field have been shown to pass this test. Comparison of fluids using this test is likely to be an indicator of which fluids may have better field performance. This test is recommended in the SAE J3200, Surface Vehicle Information Report Fluid for Automotive Electrified Drivetrains.

6. Apparatus

6.1 *Conductive Deposit Test (CDT) Assembly,* consisting of a blank board and a circuit board placed in the circuit board holder so the measurement circuit faces the blank board with a tight gap around the measurement circuit. Additional metal clips are used between the wicking holes to ensure correct gap spacing (see equipment manual for spacing details).

6.2 *Circuit Board Holder*[4], to hold the board stack, provide precise spacing between the boards, and position the boards in the test fluid and the test cell.

6.3 *Blank Board*[4,5], made of FR4 material with the same dimensions as the circuit board.

6.4 *Circuit Board*[4,5], made of FR4 material with a circuit of bare copper for resistance in the liquid and vapor phases of the specimen and continuity measurement on one side, and connections to the data acquisition unit (see equipment manual for circuit details and board dimensions).

6.5 *Conductive Deposit Circuit Board Test Instrument*[4,5], consisting of a constant-temperature bath, data acquisition unit, carousel (optional), test cell, and circuit board holder, provides the means of applying test conditions to the specimen, circuit board, and blank board, to determine the tendency of the test fluid to create conductive deposits on electrical components with exposed copper.

6.6 *Constant-temperature Bath,* a liquid or dry bath capable of controlling the bath medium to within 0.5 °C of the set point with a set point from 40 °C to 180 °C.

6.7 *Data Acquisition Unit*[4], consisting of electrical circuitry that delivers low power to each circuit, reads the resistance and continuity measurements from each circuit, and reads the liquid and vapor temperature measurements of the bath.

6.8 *Syringe,* 20 mL capacity, with 1 mL markings.

6.9 *Syringe,* approximately 50 mL capacity, for use with the liquid bath only, capable of transferring silicone oil, for adjusting the level of the heating medium in the liquid bath once it has reached temperature.

6.10 *Test Cell*[4], made of stainless steel with set internal dimensions (see equipment manual for dimensions) to hold the test fluid and circuit board stack.

[4] The sole source of supply of the apparatus known to the committee at this time is Tannas Co., 4800 James Savage Rd., Midland, MI 48640, www.tannasking.com.. If you are aware of alternative suppliers, please provide this information to ASTM International Headquarters. Your comments will receive careful consideration at a meeting of the responsible technical committee,[1] which you may attend.

[5] The Conductive Deposit Circuit Board Test Instrument, Circuit Board, and the use of the Blank Board in this test are covered by a patent (pending). Interested parties are invited to submit information regarding the identification of an alternative(s) to this patented item to the ASTM International Headquarters. Your comments will receive careful consideration at a meeting of the responsible technical committee, which you may attend.

iTeh Standards (https://standards.iteh.ai) Document Preview
ASTM D8544-24 https://standards.iteh.ai/catalog/standards/sist/...