Designation: D 1807 – ~~94~~00

Standard Test Methods for Refractive Index and Specific Optical Dispersion of Electrical Insulating Liquids [1]

This standard is issued under the fixed designation D 1807; 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 These test methods cover the determination of the refractive index and the specific optical dispersion of electrical insulating liquids such as are used in capacitors, transformers, circuit breakers, and oil-filled cables.

1.2 Two test methods are described, a routine method and a more precise referee method. Both methods are applicable to transparent, light-colored, insulating liquids.

1.2.1 The routine method is used to determine refractive index and specific optical dispersion as described in these test methods.

1.2.2 The referee method is used when a test of high accuracy is desired. These methods are described in Test Method D 1218. Specific optical dispersion is calculated by dividing the refractive dispersion value determined in Test Method D 1218 by the relative density (specific gravity) (see Practice D 1298) of the liquid under test.

1.3 The values stated in SI units are to be regarded as the 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 and health practices and determine the applicability of regulatory limitations prior to use.*

2. Referenced Documents

2.1 *ASTM Standards:*

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[1] These test methods are under the jurisdiction of ASTM Committee D-27 on Electrical Insulating Liquids and Gases and are the direct responsibility of Subcommittee D27.07 on Physical Tests.

Current edition approved ~~July 15, 1994.~~ April 10, 2000. Published ~~September 1994.~~ June 2000. Originally published as D 1807 – 60. Last previous edition ~~D 1807 – 84 (1989).~~ D 1807 – 94.

D 1218 Test Method for Refractive Index and Refractive Dispersion of Hydrocarbon Liquids [2]

D 1298 Practice for Density, Relative Density (Specific Gravity), or API Gravity of Crude Petroleum and Liquid Petroleum Products by Hydrometer Method [2]

3. Terminology

3.1 *Definitions:*

3.1.1 *refractive index, n*—the ratio of the velocity of light in air to its velocity in the substance under test.

3.1.2 *relative density (specific gravity), n*—the ratio of the mass of a given volume of liquid at 15°C (60°F) to mass of an equal volume of pure water at the same temperature.

3.1.3 *specific optical dispersion, n*—the difference between the refractive indexes of light of two different wavelengths, both indexes measured at the same temperature, and divided by the relative density (specific gravity), also measured at the test temperature.

4. Significance and Use

4.1 *Refractive Index*—The refractive index of an insulating liquid varies with its composition and with the nature and amount of contaminants held in solution. Changes of refractive index with time and service may form a basis for estimating any change in composition or the degree of containment acquired in service. For electrical insulating mineral oils, the wavelength of 5893 Å for the spectral line of sodium is commonly used. The test temperature is 25°C.

4.2 *Specific Optical Dispersion*—Specific optical dispersion serves as a quick index to the amount of unsaturated compounds present in an oil. Dispersion values for paraffinic and naphthenic compounds are nearly the same and are essentially independent of molecular weight and structural differences. Values above 97 bear a direct relationship to the amount of aromatic compounds present in insulating oil. For convenience, the specific dispersion value is multiplied by 10^4. For electrical insulating mineral oils, the wavelengths of 6563 and 4861 Å corresponding to the spectral lines of hydrogen are commonly used. Alternatively, the wavelengths of 6678 and 5016 Å corresponding to the spectral lines of helium may be used.

5. Apparatus

5.1 *Refractometer*—The refractometer to be used in the routine method shall have an index range of approximately 1.33 to 1.5 and be readable to ±0.0002 units. The refractometer used in the referee method is described in Test Method D 1218.

5.2 *Light Source*—A suitable incandescent illuminator shall be used as a light source for determinations made by the routine method; suitable light sources for the referee method are described in Test Method D 1218.

5.3 *Thermostat*—A thermostat capable of supplying water to the jacketed prisms of the refractometer shall be capable of maintaining a temperature constant to within ±0.1°C.

6. Procedure for Routine Method

6.1 Periodically check the adjustment of the refractometer with the reference standard supplied with the instrument.

6.2 Clean the instrument in accordance with the instructions furnished by the apparatus manufacturer before testing each specimen. If no special instructions are provided, clean the prisms with ~~clinical ether wiping~~ a swab of surgical grade absorbent cotton saturated with a suitable solvent such as toluene. Do not dry the ~~surfaces immediately~~ prism faces by rubbing with dry ~~surgical~~ cotton. Allow ~~2~~ 4–5 min for temperature equilibration before applying the test specimen to the prism.

6.3 Adjust the bath thermostat to 25.0°C, reading this temperature on the refractometer thermometer on the discharge side. Continue the flow of water long enough before testing to ensure that a constant temperature has been reached. If only the specific optical dispersion is desired, the measurements may be made at room temperature without use of a temperature-controlled bath.

6.4 Apply the test specimen to the surface of the refracting prism or to the capillary opening with a ~~round-end glass rod. Allow 2 min for temperature equilibration.~~ small pipet or medicine dropper.

6.5 Read the refractive index to three decimal places and estimate the fourth place.

6.6 Test additional specimens until three readings that do not show a spread of more than two units in the fourth decimal place have been secured. Record the refractive index as the average of these readings to four decimal places.

6.7 Read the compensator dial in two positions and average the values.

6.8 Calculate the specific optical dispersion by first computing the refractive dispersion. Use the nomograph or table provided with the instrument. Divide the dispersion value by the relative density (specific gravity) of the oil corrected to the temperature at which the dispersion readings were made. Determine the relative density (specific gravity) in accordance with Practice D 1298.

7. Procedure for Referee Method

7.1 Determine the refractive index and refractive dispersion in accordance with Test Method D 1218.

7.2 Calculate the specific optical dispersion by dividing the dispersion value by the relative density (specific gravity) of the oil. Correct to the temperature at which the dispersion readings were made. Determine the specific gravity in accordance with Practice D 1298.

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[2] *Annual Book of ASTM Standards*, Vol 05.01.

8. Report

8.1 Report the following:

8.1.1 A description of the sample, such as fluid type, sample location, physical appearance, etc.

8.1.2 Refractive index, reported to the fourth decimal place, and the temperature at which the test was made.

8.1.3 Multiply the specific optical dispersion value by 10^4, and for the routine method report the result as a whole number of two or three digits. For the referee method, report the results as a three or four-digit number, the last digit occupying the first decimal place.

8.1.4 The spectral line, or lines, used in the measurements.

9. Precision and Bias

9.1 *Precision*:

9.1.1 The precision of the routine method for measuring refractive index and specific optical dispersion of this test method is being determined.

9.1.2 The precision of the referee method for measuring refractive index and specific optical dispersion is essentially specified in Test Method D 1218.

9.2 *Bias*:

9.2.1 No information can be presented on the bias of the routine procedure in this test method for measuring refractive index and specific optical dispersion because no material having an accepted reference value is available.

9.2.2 The bias of the referee procedure for measuring refractive index and specific optical dispersion is essentially specified in Test Method D 1218.

10. Keywords

10.1 insulating liquids; refractive index; refractometer; specific optical dispersion