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AMERICAN SOCIETY FOR TESTING AND MATERIALS
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Standard Test Method for Measurement of Turbidity in Mineral Insulating Oil of Petroleum Origin¹

This standard is issued under the fixed designation D 6181; 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 laboratory procedure that ascertains the quantity of suspensions in insulating oils of petroleum origin using a nephelometric measurement technique to determine the fluid's turbidity. This test method is designed to reveal changes that may occur to these oils.

1.2 This test method is applicable for turbidities in the range of 0.1 to 500 Nephelometric Turbidity Units (NTU).

1.3 The values stated in SI units are to be regarded as the standard. The values given in parentheses are for information only.

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:

- D 923 Test Method for Sampling Electrical Insulating Liquids²
- D 1533 Test Methods for Water in Insulating Liquids (Karl Fischer Reaction Method)²
- D 1698 Test Method for Sediments and Soluble Sludge in Service Aged Insulating Oils²
- D 1889 Test Method for Turbidity of Water³
- D 4652 Specification for Silicone Fluid Used for Electrical Insulation²
- D 5180 Test Method for Quantitative Test for Turbidity in Clear Liquids⁴
- E 177 Practice for Use of the Terms Precision and Bias in ASTM Test Methods⁵

3. Terminology

3.1 Description of Terms Specific to This Standard:

3.1.1 *nephelometric turbidity unit (NTU)*, *n*—intensity of light scattered by a known aqueous suspension of formazine.

¹ This test method is under the jurisdiction of ASTM Committee D-27 on Electrical Insulating Liquids and Gases and is the direct responsibility of Subcommittee D27.07 on Physical Test.

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² Annual Book of ASTM Standards, Vol 10.03.

³ Annual Book of ASTM Standards, Vol 11.01.

⁴ Annual Book of ASTM Standards, Vol 06.03.

⁵ Annual Book of ASTM Standards, Vol 14.02.

One NTU is the turbidity of a formazine solution produced by mixing 12.5 µg of hydrazine sulfate and 1.25 µg of hexamethylenetetramine in 1 mL of turbidity-free water. See Appendix X1 for preparation instructions.

3.1.2 *turbidity, n*—the reduction of transparency due to the presence of particulate matter.

4. Summary of Test Method

4.1 The turbidity is determined by a calibrated, ratio turbidimeter, which measures scattered light at 0.5 π rad (90°) or 0.5 and 1.5 π rad (90 and 270°) angles to the incident beam. These instruments cannot be calibrated accurately in terms of absolute turbidity except in the case of fluids having uniform-size particles that are less than approximately one fifth of the wave length of the incident light. Standards have been prepared by thoroughly mixing suitable amounts of finely divided titanium dioxide into partially polymerized polystyrene. Alternatively, suspension of formazine has been used as a turbidity standard, formed by reacting hydrazine sulfate and hexamethylenetetramine under carefully controlled conditions.⁶ Calibrated commercial standards in sealed tubes also are available.

4.2 The test specimen is placed in the cell and its turbidity is measured. The turbidimeter measures the light scattered by suspended solids dispersed within the test specimen. Accuracy and sensitivity of the method is ensured by measuring the turbidity at a wavelength of light where there is little or no absorption of the light by the test specimen. Use of a narrow bandwidth of light reduces interference that may be inherent to these insulating oils. The narrow bandwidth is achieved through the use of an optical filter to provide light at 600 nm with a 40 nm bandwidth.

4.3 This test method is recommended only for mineral oils and is not intended to be used on other fluids.

5. Significance and Use

5.1 This test method uses a ratio turbidimetric optical system to measure the turbidity of insulating oils relative to turbidity standards. Cloudiness or turbidity is attributed to matter whose diameter is approximately 20 % of the wavelength of the incident light. Increasing turbidity signifies increasing transformer fluid contamination. This test method

⁶ For information, see Chevalier, P., "Formazine Standard for Turbidity," Brasserie, Vol 152, 1959, pp. 132–133.