



Designation: D 3487 – 00

Standard Specification for Mineral Insulating Oil Used in Electrical Apparatus¹

This standard is issued under the fixed designation D 3487; 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 approval. A superscript epsilon (ϵ) indicates an editorial change since the last revision or reapproval.

This standard has been approved for use by agencies of the Department of Defense.

1. Scope

1.1 This specification covers new mineral insulating oil of petroleum origin for use as an insulating and cooling medium in new and existing power and distribution electrical apparatus, such as transformers, regulators, reactors, circuit breakers, switchgear, and attendant equipment.

1.2 This specification is intended to define a mineral insulating oil that is functionally interchangeable and miscible with existing oils, is compatible with existing apparatus and with appropriate field maintenance,² and will satisfactorily maintain its functional characteristics in its application in electrical equipment. This specification applies only to new insulating oil as received prior to any processing.

2. Referenced Documents

2.1 ASTM Standards:

- D 88 Test Method for Saybolt Viscosity³
- D 92 Test Method for Flash and Fire Points by Cleveland Open Cup⁴
- D 97 Test Method for Pour Point of Petroleum Products⁴
- D 445 Test Method for Kinematic Viscosity of Transparent and Opaque Liquids⁴
- D 611 Test Methods for Aniline Point and Mixed Aniline Point of Petroleum Products and Hydrocarbon Solvents⁴
- D 877 Test Method for Dielectric Breakdown Voltage of Insulating Liquids Using Disk Electrodes⁵
- D 923 Test Method for Sampling Electrical Insulating Liquids⁵
- D 924 Test Method for Dissipation Factor (or Power Factor) and Relative Permittivity (Dielectric Constant) of Electrical Insulating Liquids⁵
- D 971 Test Method for Interfacial Tension of Oil Against

- Water by the Ring Method⁵
- D 974 Test Method for Acid and Base Number by Color-Indicator Titration⁴
- D 1275 Test Method for Corrosive Sulfur in Electrical Insulating Oils⁵
- D 1298 Test Method for Density, Relative Density (Specific Gravity), or API Gravity of Crude Petroleum and Liquid Petroleum Products by Hydrometer Method^{4,5}
- D 1500 Test Method for ASTM Color of Petroleum Products (ASTM Color Scale)⁴
- D 1524 Test Method for Visual Examination of Used Electrical Insulating Oils of Petroleum Origin in the Field⁵
- D 1533 Test Methods for Water in Insulating Liquids (Karl Fischer Reaction Method)⁵
- D 1816 Test Method for Dielectric Breakdown Voltage of Insulating Oils of Petroleum Origin Using VDE Electrodes⁵
- D 1903 Test Method for Coefficient of Thermal Expansion of Electrical Insulating Liquids of Petroleum Origin, and Askarels⁵
- D 2112 Test Method for Oxidation Stability of Inhibited Mineral Insulating Oil by Rotating Bomb⁵
- D 2300 Test Method for Gassing of Insulating Oils Under Electrical Stress and Ionization (Modified Pirelli Method)⁵
- D 2440 Test Method for Oxidation Stability of Mineral Insulating Oil⁵
- D 2668 Test Method for 2,6-Ditertiary-Butyl Para-Cresol and 2,6-Ditertiary-Butyl Phenol in Electrical Insulating Oil by Infrared Absorption⁵
- D 2717 Test Method for Thermal Conductivity of Liquids⁶
- D 2766 Test Method for Specific Heat of Liquids and Solids⁶
- D 3300 Test Method for Dielectric Breakdown Voltage of Insulating Oils of Petroleum Origin Under Impulse Conditions⁵
- D 4059 Test Method for Analysis of Polychlorinated Biphenyls in Insulating Liquids by Gas Chromatography⁵
- D 4768 Test Method for Analysis of 2,6-Ditertiary-Butyl Para-Cresol and 2,6-Ditertiary-Butyl Phenol in Insulating Fluids by Gas Chromatography⁵

¹ This specification is under the jurisdiction of ASTM Committee D27 on Electrical Insulating Liquids and Gases and is the direct responsibility of Subcommittee D27.01 on Mineral.

Current edition approved Nov. 10, 2000. Published January 2001. Originally published as D3487 – 76. Last previous edition D3487 – 88 (1993).

² Refer to American National Standard C 57.106. Guide for Acceptance and Maintenance of Insulating Oil in Equipment (IEEE Standard 64). Available from the American National Standards Institute, 11 West 42nd Street, 13th Floor, New York, NY 10036.

³ Annual Book of ASTM Standards, Vol 04.04.

⁴ Annual Book of ASTM Standards, Vol 05.01.

⁵ Annual Book of ASTM Standards, Vol 10.03.

⁶ Annual Book of ASTM Standards, Vol 05.02.

D 5837 Test Method for Furanic Compounds in Electrical Insulating Liquids by High Performance Liquid Chromatography (HPLC)⁵

3. Terminology Definitions

3.1 *Type I Mineral Oil*—an oil for apparatus where normal oxidation resistance is required. Some oils may require the addition of a suitable oxidation inhibitor to achieve this.

3.2 *Type II Mineral Oil*—an oil for apparatus where greater oxidation resistance is required. This is usually achieved with the addition of a suitable oxidation inhibitor.

NOTE 1—During processing of inhibited mineral oil under vacuum and elevated temperatures, partial loss of inhibitor and volatile portions of mineral oil may occur. The common inhibitors, 2,6-ditertiary-butyl para-cresol and 2,6-ditertiary-butyl phenol, are more volatile than transformer oil. If processing conditions are too severe, oxidation stability of the oil may be decreased due to loss of inhibitor. The selectivity for removal of moisture and air in preference to loss of inhibitor and oil is improved by use of a low processing temperature.

Conditions that have been found satisfactory for most inhibited mineral oil processing are:

Temperature, °C	Minimum Pressure	
	Pa	Torr, Approximate
40	5	0.04
50	10	0.075
60	20	0.15
70	40	0.3
80	100	0.75
90	400	3.0
100	1000	7.5

If temperatures higher than those recommended for the operating pressure are used, the oil should be tested for inhibitor content and inhibitor added as necessary to return inhibitor content to its initial value. Attempts to dry apparatus containing appreciable amounts of free water

may result in a significant loss of inhibitor even at the conditions recommended above.

3.3 *additives*—chemical substances that are added to mineral insulating oil to achieve required functional properties.

3.4 *properties*—those properties of the mineral insulating oil which are required for the design, manufacture, and operation of the apparatus. These properties are listed in Section 5.

4. Sampling and Testing

4.1 Take all oil samples in accordance with Test Methods D 923.

4.2 Make each test in accordance with the latest revision of the ASTM test method specified in Section 5.

4.3 The oil shall meet the requirements of Section 5 at the unloading point.

NOTE 2—Because of the different needs of the various users, items relating to packaging, labeling, and inspection are considered to be subject to buyer-seller agreement.

NOTE 3—In addition to all other tests listed herein, it is sound engineering practice for the apparatus manufacturer to perform an evaluation of new types of insulating oils in insulation systems, prototype structures, or full-scale apparatus, or any combination thereof, to assure suitable service life.

4.4 Make known to the user the generic type and amount of any additive used, for assessing any potential detrimental reaction with other materials in contact with the oil.

5. Property Requirements

5.1 Mineral insulating oil conforming to this specification shall meet the property limits given in Table 1. The significance of these properties is discussed in Appendix X2.

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