Designation: D 3455 – 02

Standard Test Methods for Compatibility of Construction Material with Electrical Insulating Oil of Petroleum Origin [1]

This standard is issued under the fixed designation D 3455; 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 screening for the compatibility of materials of construction with electrical insulating oil for use in electrical equipment.

1.2 *This standard does not purport to address all of the safety problems, 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 877 Test Method for Dielectric Breakdown Voltage of Insulating Liquids Using Disk Electrodes [2]

D 924 Test Method for Dissipation Factor (or Power Factor) and Relative Permittivity (Dielectric Constant) of Electrical Insulating Liquids [2]

D 971 Test Method for Interfacial Tension of Oil Against Water by the Ring Method [2]

D 974 Test Method for Acid and Base Number by Color-Indicator Titration [3]

D 1500 Test Method for ASTM Color of Petroleum Products (ASTM Color Scale) [3]

D 2413 Practice for Preparation of Insulating Paper and Board Impregnated with a Liquid Dielectric [4]

D 3487 Specification for Mineral Insulating Oil Used in Electrical Apparatus [2]

3. Significance and Use

3.1 The magnitude of the changes in the electrical properties of the insulating oil are of importance in determining the contamination of the oil by the test specimen.

3.2 Physical and chemical changes in the oil such as color, interfacial tension and acidity, also indicate solubility or other adverse effects of the test specimen on the oil.

3.3 Physical changes of the test specimen such as hardness, swelling, and discoloration show the effect of the oil on the test specimen and are used to determine the suitability of the material for use in insulating oil.

3.4 A material meeting the criteria recommended does not necessarily indicate suitability for use in electrical equipment. Other properties must also be considered. Additionally, certain materials containing additives may meet the requirements of these test methods, yet be unsatisfactory when subjected to longer term evaluations. Examples of such materials are polyvinyl chloride (PVC) based compounds, nylon and elastomeric compounds.

4. Apparatus

4.1 *Sample-Handling Apparatus*:

4.1.1 *Oven*, forced-draft, adjustable to 100 ± 1°C, and a drying oven, adjustable to 105 ± 5°C.

4.1.2 *Glass Containers*, 1-L, fitted with glass or aluminum foil covers.

NOTE 1—Other materials have been found to be suitable as covers.

4.2 *Sample-Testing Apparatus*:

4.2.1 *Tensile Strength*—As specified in appropriate test method.

4.2.2 *Hardness*—As specified in appropriate test method.

4.2.3 *Dimensional Change*—Micrometer and caliper.

4.2.4 *Weight Change*—Analytical balance.

5. Preparation of Test Specimen

5.1 Test specimen size shall be such that the ratio of surface area to oil volume is four times as large as the ratio encountered in normal use in electrical equipment unless there is some special reason for using a different ratio (Note 2). Some suggested ratios are as follows:

5.1.1 If the test specimen can be measured, no less than 52 cm^2 are used with each 800 mL of oil.

5.1.2 If the test specimen is insoluble in oil and the surface area cannot be measured, the test specimen shall be used in the amount of 1 % by the weight of the oil.

5.1.3 If the material is soluble in the oil, the test specimen shall be used in the amount of 0.5 % by the weight of the oil.

5.1.4 Varnishes and materials used as dip coatings shall be cured on aluminum foil or paper known to be compatible with

[1] These test methods are under the jurisdiction of ASTM Committee D27 on Electrical Insulating Liquids and Gasesand are the direct responsibility of Subcommittee D27.06on Chemical Tests.

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[2] *Annual Book of ASTM Standards*, Vol 10.03.

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

[4] *Annual Book of ASTM Standards*, Vol 10.01.

insulating oil. They should be tested at a ratio of 14 g or approximately 1300 cm^2 of surface area per 800 mL of oil.

5.1.5 Core steel and core-steel coatings shall be tested at a ratio of 3100 cm^2 for each 400 mL of oil, for transformer applications. A realistic core steel ratio for regulators is 5000 cm^2 of surface area per each 400 mL of oil.

5.1.6 Gasket materials shall be tested at a ratio of 65 cm^2 surface area per 800 mL of oil.

5.1.7 Wire enamels shall be tested at a ratio of 1300 cm^2 of surface area per 800 mL of oil.

NOTE 2—There are certain materials in electrical apparatus where the suggested ratios of material to oil are impractical; when this condition exists, the ratio shall be reported.

5.2 Caution must be taken in obtaining and preparing the test specimen to ensure that it is representative of the material as supplied by the manufacturer. Do not handle with fingers.

5.3 Pre-dry all solid materials for 16 h in an oven at 105 ± 5°C. Use care when testing specimens which are comprised of paper or applied to paper to limit damage to the paper from drying in an air circulating oven. It is recommended that such components be dried and impregnated in a vacuum oven as outlined in Practice D 2413, Section 9.1.1, to reduce the effects of oxygen on the paper.

5.4 Remove the test specimen from the oven and place in a 1-L jar with 800 mL of approved insulating oil (Note 3), meeting all the limits required for new oil. Bubble dry nitrogen through the oil for approximately 10 min, and place the cover on the jar.

NOTE 3—An approved oil is one that meets the requirements of Specification D 3487, or an oil specified by the material purchaser.

5.5 Prepare a reference oil specimen from 800 mL of the approved oil alone as a control for each group of specimens tested.

6. Conditioning

6.1 Place the covered glass jars in an oven at 100 ± 1°C for 164 h.

6.2 Remove the jars from the oven and cool to room temperature.

7. Procedure

7.1 With a pair of clean tongs remove the test specimen from the oil, observe the condition, and conduct any desired test on the material.

7.1.1 Typical tests on materials can include swelling or dimensional change, hardness, discoloration, brittleness, etc.

7.1.2 For comparative tests use the appropriate method.

7.2 The following tests on all oil specimens are suggested:

7.2.1 *Interfacial Tension*—Test Method D 971.

7.2.2 *Neutralization Number*—Test Method D 974.

7.2.3 *Dielectric Strength*—Test Method D 877.

7.2.4 *Dissipation (Power Factor)*—Test Method D 924.

7.2.5 *Color*—Test Method D 1500.

8. Evaluation of Results

8.1 *Evaluation of Physical Changes of the Material at Room Temperature*—The changes in physical properties of the material being tested must be considered on the basis of the specific needs of the application.

8.2 *Evaluation of Test Results on Insulating Oil*:

8.2.1 The test results obtained on the oils containing the test specimens must be compared with those of the reference oil specimen to determine any differences.

8.2.2 The absence of any differences between the test specimen oil and the reference oil indicates that the test specimen oil was not affected by the material and that the material is worthy of further consideration or testing, or both.

8.2.3 A significant difference in any of the results as defined in 8.2.5 may indicate some compatibility problem and the material should be either further reviewed or rejected.

8.2.3.1 The magnitude of differences in properties between the reference oil and the test specimen oil that constitute a significant change should be established prior to testing, by agreement between the purchaser and the seller.

8.2.4 If the aged reference oil exceeds the limits in 8.2.5, the oil itself is suspect for one or more of the following reasons:

8.2.4.1 The oil does not meet the requirements for an approved insulating oil.

8.2.4.2 The oil has become contaminated.

8.2.4.3 The test aging temperature exceeded the prescribed limit (see 6.1).

8.2.5 The aged properties for the reference oil specimen should be as follows (Note 4):

Interfacial tension	D 971	38 mN/m, min
Neutralization number	D 974	0.03 mg of KOH, max change
Dielectric strength	D 877	28 kV, min
Dissipation (Power factor), 100°C	D 924	1.1%, max
Color	D 1500	0.5 max change

NOTE 4—The values are typical values for most of the mineral oils presently on the market.

9. Report

9.1 *Report the following information*:

9.1.1 The results of the tests specified in 8.2.5, on both the reference oil specimen and the test specimen oil(s).

9.1.2 Any changes in appearance, dimensions, hardness or other relevant properties of the construction material test specimens.

9.1.3 Whether the construction material evaluated by this test method appears to be compatible (or incompatible) with electrical insulating oil.

10. Precision and Bias

10.1 No practical means exists to specify precision and bias, as this method is used to test many different liquids and materials which may age differently.

11. Keywords

11.1 compatibility; construction material; electrical equipment; insulating oil