



Designation: D 971 – 99a

Standard Test Method for Interfacial Tension of Oil Against Water by the Ring Method¹

This standard is issued under the fixed designation D 971; 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 test method covers the measurement of the interfacial tension between mineral oil and water, under non-equilibrium conditions.

1.2 *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 117 Guide to Test Methods and Specifications for Electrical Insulating Oils of Petroleum Origin²

D 923 Test Method for Sampling Electrical Insulating Liquids²

D 2285 Test Method for Interfacial Tension of Electrical Insulating Oils of Petroleum Origin Against Water by the Drop-Weight Method²

3. Summary of Test Method

3.1 *Interfacial Tension* is determined by measuring the force necessary to detach a planar ring of platinum wire from the surface of the liquid of higher surface tension, that is, upward from the water-oil interface. To calculate the interfacial tension, the force so measured is corrected by an empirically determined factor which depends upon the force applied, the densities of both oil and water, and the dimensions of the ring. Measurements are made under rigidly standardized nonequilibrium conditions in which the measurement is completed within 60 s after formation of the interface.

4. Significance and Use

4.1 Interfacial tension measurements on electrical insulating oils provide a sensitive means of detecting small amounts of soluble polar contaminants and products of oxidation. A high

value for new mineral insulating oil indicates the absence of most undesirable polar contaminants. The test is frequently applied to service-aged oils as an indication of the degree of deterioration.

5. Apparatus (Figs. 1 and 2)

5.1 *Tensiometer*³—Force measurement on the tensiometer may be made using a torsion wire, load cell, or any other means of linearly determining tension in the range of 0 to 100 mN/m.

5.1.1 Horizontal platform to hold the sample container should be capable of movement upward or downward using a mechanical screw, lever mechanism, electronic drive, or any other means of precisely changing vertical position of the sample.

5.2 Rings made of platinum or platinum-iridium alloy may be used. The ring should be welded into a continuous circle and attached to at least two parallel stirrups. Circumference of the ring should be minimum 40 mm and diameter of the ring wire should be about 0.3 mm. Ratio of the ring major radius (R) and the wire radius (r) should be known (R/r) to at least three significant figures. Stirrups should be at least 25 mm long.

5.2.1 The ring may be suspended from or rigidly fixed into the tensiometer force measuring system.

5.3 *Sample Container*—Glass beaker or clear cylindrical container having a minimum diameter of 45 mm.

6. Reagents

6.1 *Purity of Reagents*—Reagent grade chemicals shall be used in the test.

6.2 *Purity of Water*—Unless otherwise indicated, references to water shall be understood to mean distilled water or water of equal purity.

7. Preparation of Apparatus

7.1 Glass containers can be cleaned by rinsing in xylene, hexane or another suitable hydrocarbon solvent, followed by a rinse in acetone or methyl ethyl ketone. Following these rinses they can be cleaned using detergent in hot water and rinsed thoroughly with tap and then distilled water. Dry the glass vessel if not for immediate use.

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 Tensiometers that use the Du Nouy principle for measuring interfacial and surface tension should be used.