Designation: D 1903 – ~~96~~03

Standard Test Method for Coefficient of Thermal Expansion of Electrical Insulating Liquids of Petroleum Origin, and Askarels [1]

This standard is issued under the fixed designation D 1903; 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] This test method is under the jurisdiction of ASTM Committee D-27 on Electrical Insulating Liquids and Gasesand is the direct responsibility of Subcommittee D27.07on Physical Tests.

Current edition approved ~~Oct.~~ March 10, ~~1996.~~ 2003. Published ~~December 1996.~~ May 2003. Originally ~~published as D 1903 – 61.~~ approved in 1961. Last previous edition approved in 1996 as D 1903 – 9~~2~~6.

1. Scope

1.1 This test method covers the determination of the coef-ficient of thermal expansion of electrical insulating liquids of petroleum origin, and askarels, containing PCBs (polychlorinated biphenyls), when used as an insulating or cooling medium, or both, in cables, transformers, oil circuit breakers, capacitors, or similar apparatus.

1.2 The values given in acceptable metric units are to be regarded as the standard.

1.3 *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 941 Test Method for Density and Relative Density (Specific Gravity) of Liquids by Lipkin Bicapillary Pycnometer [2]

D 1250 Guide for Petroleum Measurement Tables [2,3]

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

D 1810 Test Method for Specific Gravity of Askarels [4]

3. Terminology

3.1 *Definition of Term Specific to This Standard:*

3.1.1 *coefficient of thermal expansion of a liquid, n*—the change in volume per unit volume per degree change in temperature. It is commonly stated as the average coefficient over a given temperature range.

4. Significance and Use

4.1 Knowledge of the coefficient of thermal expansion of a liquid is essential to compute the required size of a container to accommodate a volume of liquid over the full temperature range to which it will be subjected. It is also used to compute the volume of void space that would exist in an inelastic device filled with the liquid after the liquid has cooled to a lower temperature.

5. Procedure for Liquids of Petroleum Origin

5.1 The coefficient of thermal expansion used in Guide D 1250, is 0.00040/°F for the temperature range from − 17.7 to 65.5°C (0 to 150°F), and petroleum oils ranging from 15.0 to 34.9° API gravity or 0.9659 to 0.8504 relative density (specific gravity). In the preparation of these tables for relative density (specific gravity) values above 0.600, it has been assumed for purposes of standardization that all crude petroleum and petroleum products have uniform coefficients of expansion in the same temperature ranges. When the required accuracy of results falls within these assumptions, this value for coefficient of expansion may be used.

5.2 If closer approximation than that indicated in 5.1 is required, the coefficient of thermal expansion may be calculated by determining observed relative densities (specific gravities). Determine the ~~specific gravities~~ relative densities at any two

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

[3] These tables are issued as a separate publication in 3 volumes, American edition, British edition and Metric edition, available from ~~the American Society for Testing and Materials, 1916 Race St., Philadelphia, PA 19103.~~ ASTM International.

[4] Discontinued, See 1999 *Annual Book of ASTM Standards* , Vol 10.03.

temperatures below 90°C (194°F) and not less than 5°C (9°F), nor more than 14°C (25°F) degrees apart by Practice D 1298. The difference in the observed ~~specific gravities~~ relative densities at the two temperatures divided by the product of the ~~specific gravity~~ relative density at the lower temperature and the difference in the two temperatures may be used as the average coefficient of expansion for the observed temperature range.

6. Procedure for Askarels

6.1 Determine the relative density (specific gravity) of the askarel at any two convenient temperatures below 90°C (194°F) and not less than 14°C (25°F) apart by Test Method D 1810. The difference in the observed ~~specific gravities~~ relative densities at the two temperatures divided by the product of the ~~specific gravity~~ relative density at the lower temperature and the difference in the two temperatures may be used as the average coefficient of expansion for the observed temperature range.

6.2 If suitably calibrated hydrometers for determining the ~~specific gravity~~ relative density of an askarel are not available, Test Method D 941 may be used.

7. Calculation

7.1 Calculate the coefficient of thermal expansion as follows:

$$\text{Coefficient of thermal expansion} = (S - S_1)/S(T_1 - T)$$

where:

S = relative density (specific gravity) at lower temperature T,
S_1 = relative density (specific gravity) at higher temperature T_1,
T = lower temperature, and
T_1 = higher temperature.

8. Precision and Bias

8.1 This test method does not lend itself to a precision and bias statement, due to the fact that the coefficient of thermal expansion as determined by this test method is a calculated quantity obtained from measurements made using other standard methods.

9. Keywords

9.1 askarels; density; electrical insulating liquids; petroleum; specific gravity; volume