Designation: D2140 – 23ε1

Standard Practice for Calculating Carbon-Type Composition of Insulating Oils of Petroleum Origin[1]

This standard is issued under the fixed designation D2140; 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.

ε[1] NOTE—Research report number was added editorially in January 2024.

1. Scope

1.1 This practice may be used to determine the carbon-type composition of mineral insulating oils by correlation with basic physical properties. For routine analytical purposes it eliminates the necessity for complex fractional separation and purification procedures. The practice is applicable to oils having average molecular weights from 200 to above 600, and 0 to 50 aromatic carbon atoms.

1.2 Carbon-type composition is expressed as percentage of aromatic carbons, percentage of naphthenic carbons, and percentage of paraffinic carbons. These values can be obtained from the correlation chart, Fig. 1, if both the viscosity-gravity constant (VGC) and refractivity intercept (r_i) of the oil are known. Viscosity, density and relative density (specific gravity), and refractive index are the only experimental data required for use of this test method.

1.3 This practice is useful for determining the carbon-type composition of electrical insulating oils of the types commonly used in electric power transformers and transmission cables. It is primarily intended for use with new oils, either inhibited or uninhibited.

1.4 The values stated in SI units are to be regarded as standard. No other units of measurement are included in this standard.

1.5 *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, health, and environmental practices and determine the applicability of regulatory limitations prior to use.*

1.6 *This international standard was developed in accordance with internationally recognized principles on standardization established in the Decision on Principles for the Development of International Standards, Guides and Recommendations issued by the World Trade Organization Technical Barriers to Trade (TBT) Committee.*

2. Referenced Documents

2.1 *ASTM Standards:*[2]

D129 Test Method for Sulfur in Petroleum Products (General High Pressure Decomposition Device Method) (Withdrawn 2023)[3]

D445 Test Method for Kinematic Viscosity of Transparent and Opaque Liquids (and Calculation of Dynamic Viscosity)

D923 Practices for Sampling Electrical Insulating Liquids

D1218 Test Method for Refractive Index and Refractive Dispersion of Hydrocarbon Liquids

D1481 Test Method for Density and Relative Density (Specific Gravity) of Viscous Materials by Lipkin Bicapillary Pycnometer (Withdrawn 2023)[3]

D2007 Test Method for Characteristic Groups in Rubber Extender and Processing Oils and Other Petroleum-Derived Oils by the Clay-Gel Absorption Chromatographic Method

D2501 Test Method for Calculation of Viscosity-Gravity Constant (VGC) of Petroleum Oils

D3238 Test Method for Calculation of Carbon Distribution and Structural Group Analysis of Petroleum Oils by the n-d-M Method

D4052 Test Method for Density, Relative Density, and API Gravity of Liquids by Digital Density Meter

D7042 Test Method for Dynamic Viscosity and Density of Liquids by Stabinger Viscometer (and the Calculation of Kinematic Viscosity)

3. Terminology

3.1 *Definitions:*

[1] This practice is under the jurisdiction of ASTM Committee D27 on Electrical Insulating Liquids and Gases and is the direct responsibility of Subcommittee D27.07 on Physical Test.

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[2] For referenced ASTM standards, visit the ASTM website, www.astm.org, or contact ASTM Customer Service at service@astm.org. For *Annual Book of ASTM Standards* volume information, refer to the standard's Document Summary page on the ASTM website.

[3] The last approved version of this historical standard is referenced on www.astm.org.

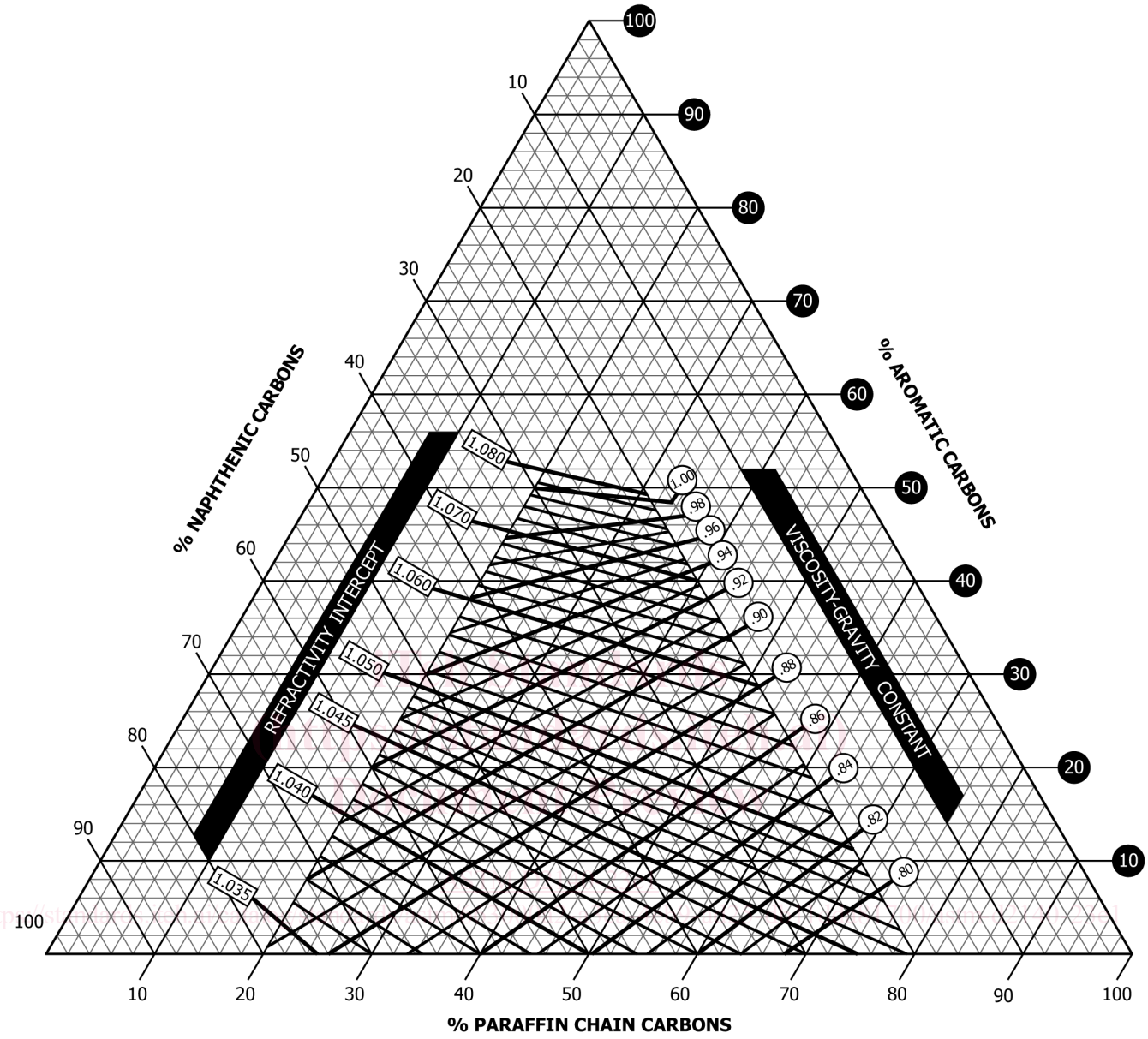

FIG. 1 Correlation Chart for Determining % C_A, % C_N, and % C_P

3.1.1 *percent of aromatic carbons (% C_A), n*—the weight percent of the total carbon atoms present in an oil that are combined in aromatic ring-type structures.

3.1.2 *percent of naphthenic carbons (% C_N), n*—the weight percent of the total carbon atoms present in an oil that are combined in naphthenic ring-type structures.

3.1.3 *percent of paraffinic carbons (% C_P), n*—the weight percent of the total carbon atoms present in an oil that are combined in paraffinic chain-type structures.

NOTE 1—The resolution of carbon atoms into structural classifications is independent of whether the structures exist as separate molecules or are combined with other structural forms in a molecule. For example, a paraffinic chain may be either an aliphatic hydrocarbon molecule, or may be an alkyl group attached to an aromatic or naphthenic ring.

4. Summary of Practice

4.1 A sample of the oil is tested to determine its viscosity, density and relative density (specific gravity), and refractive index. From these measured properties the viscosity-gravity constant (VGC) and refractivity intercept (r_i) are obtained by calculation, using the equations given. The calculated values of VGC and r_i are used with Fig. 1, to correlate those parameters with carbon-type composition. The composition in terms of % C_A, % C_N, and % C_P may be read directly from Fig. 1.

NOTE 2—Fig. 1 is a form of correlation chart that has been found satisfactory for use with this method. Other chart forms may be devised and used in preference to Fig. 1 if it is determined that the data obtained are consistent with similar data from Fig. 1. In addition, some users will find it convenient to develop a computer program or spreadsheet which will provide a consistent evaluation of the data.