Designation: D8519 – 23

Standard Test Method for Determination of Hydrocarbon Types in Waste Plastic Process Oil Using Gas Chromatography with Vacuum Ultraviolet Absorption Spectroscopy Detection (GC-VUV)[1]

This standard is issued under the fixed designation D8519; 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 This test method covers a standard procedure for the determination of hydrocarbon types (saturates, olefins, styrenes, aromatics and polyaromatics) of waste plastic process oil (WPPO) from chemical or thermal processes using gas chromatography and vacuum ultraviolet absorption spectroscopy detection (GC-VUV).

1.1.1 This test method is applicable for plastic recycling and circular schemes including wide range density material from polyethylene and polypropylene.

1.1.2 The test method is applicable to waste plastic process oil having a final boiling point of 545 °C or lower at atmospheric pressure as measured by this test or Test Method D2887. This test method is limited to samples having a boiling range greater than 36 °C, and having a vapor pressure sufficiently low to permit sampling at ambient temperature.

1.1.3 WPPOs with initial boiling points less than nC5 (36 °C) and final boiling point less than nC15 (271 °C) may be analyzed by Test Method D8369.

1.1.4 Appendix X3 is applicable to waste plastic process oils that are predominantly hydrocarbons in the boiling range of pentane, nC5 (36 °C) to tetrahexacontane, nC64 (629 °C).

1.2 Concentrations of group type totals are determined by percent mass or percent volume. The applicable working ranges are as follows:

Total Aromatics	%Mass	1 to 50
Monoaromatics	%Mass	1 to 50
Diaromatics	%Mass	1 to 15
Tri-plus aromatics	%Mass	0.5 to 5
PAH	%Mass	0.5 to 15
Saturates	%Mass	5 to 99
Olefins	%Mass	1 to 80
Conjugated diolefins	%Mass	0.2 to 5
Styrenes	%Mass	0.2 to 5

The final precision concentration ranges will be defined by a future ILS.

1.2.1 Saturates totals are the result of the summation of normal paraffins, isoparaffins, and naphthenes.

1.2.2 Aromatics are the summation of monoaromatic and polyaromatic group types. Polyaromatic totals are the result of the summation of diaromatic and tri-plus aromatic group types.

1.2.3 Olefin totals are the result of the sum of mono-olefins, conjugated diolefins, non-conjugated diolefins, and cyclic olefins.

1.2.4 Styrenes totals are the sum of styrene and alkylated styrenes. Styrenes are classified separately, neither as aromatic nor olefin.

1.3 Waste plastic process oil containing mixed plastic types such as polyethylene terephthalate PET and polyvinyl chloride or other material may yield compounds including heterocompounds that are not speciated by this test method.

1.4 Individual components are typically not baseline separated by the procedure described in this test method. The coelutions are resolved at the detector using VUV absorbance spectra and deconvolution algorithms.

1.5 This test method may apply to other process oils from sources such as tires and bio-mass boiling between pentane (36 °C) and tetratetracontane (545 °C), but has not been extensively tested for such applications.

1.6 *Units*—The values stated in SI units are to be regarded as standard. No other units of measurement, other than the boiling point of normal paraffins (°F) in Table 2 and Table X.3.1, are included in this standard.

1.7 *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.*

1.8 *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.*

[1] This test method is under the jurisdiction of ASTM Committee D02 on Petroleum Products, Liquid Fuels, and Lubricants and is the direct responsibility of Subcommittee D02.04.0L on Gas Chromatography Methods.

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2. Referenced Documents

2.1 *ASTM Standards:*[2]

D2887 Test Method for Boiling Range Distribution of Petroleum Fractions by Gas Chromatography

D4057 Practice for Manual Sampling of Petroleum and Petroleum Products

D4175 Terminology Relating to Petroleum Products, Liquid Fuels, and Lubricants

D4307 Practice for Preparation of Liquid Blends for Use as Analytical Standards

D6299 Practice for Applying Statistical Quality Assurance and Control Charting Techniques to Evaluate Analytical Measurement System Performance

D6300 Practice for Determination of Precision and Bias Data for Use in Test Methods for Petroleum Products, Liquid Fuels, and Lubricants

D6730 Test Method for Determination of Individual Components in Spark Ignition Engine Fuels by 100-Metre Capillary (with Precolumn) High-Resolution Gas Chromatography

D6792 Practice for Quality Management Systems in Petroleum Products, Liquid Fuels, and Lubricants Testing Laboratories

D7169 Test Method for Boiling Point Distribution of Samples with Residues Such as Crude Oils and Atmospheric and Vacuum Residues by High Temperature Gas Chromatography

D7213 Test Method for Boiling Range Distribution of Petroleum Distillates in the Boiling Range from 100 °C to 615 °C by Gas Chromatography

D7372 Guide for Analysis and Interpretation of Proficiency Test Program Results

D8369 Test Method for Detailed Hydrocarbon Analysis by High Resolution Gas Chromatography with Vacuum Ultraviolet Absorption Spectroscopy (GC-VUV)

3. Terminology

3.1 *Definitions:*

3.1.1 For definitions of terms used in this test method, refer to Terminology D4175.

3.2 *Definitions of Terms Specific to This Standard:*

3.2.1 *alpha olefins (or α-olefins), n*—alkenes (also known as olefins) with a chemical formula CxH2x, distinguished by having a double bond at the primary or alpha (α) position.

3.2.1.1 *Discussion*—α-olefins in WPPO are primarily straight chain hydrocarbons.

3.2.2 *alpha-omega olefins (or α-ω olefins), n*—dialkenes (also known as diolefins) with a chemical formula $(CH_2)n(CH{=}CH_2)_2$, distinguished by having a double bond at both the alpha (α) and omega (ω) positions.

3.2.2.1 *Discussion*—α- ω olefins in WPPO are primarily straight chain hydrocarbons and are generally non-conjugated diolefins.

3.2.3 *diaromatic hydrocarbons, n*—hydrocarbon compounds containing two aromatic rings; this group includes naphthalene, biphenyls, acenaphthene, acenaphthylene, and alkylated derivatives of these hydrocarbons.

3.2.4 *integration filter, n*—a mathematical operation performed on an absorbance spectrum for the purpose of converting the spectrum to a single-valued response suitable for representation in a two-dimensional chromatogram plot.

3.2.5 *library reference spectrum, n*—an absorbance spectrum representation of a molecular species stored in a library database and used for identification of a compound/compound class or deconvolution of multiple coeluting compounds.

3.2.6 *monoaromatic hydrocarbons, n*—hydrocarbon compounds containing one aromatic ring; including benzene, alkyl-substituted benzenes, indans, tetralins, alkyl-substituted indans, and alkyl-substituted tetralins.

3.2.7 *olefins, n*—alkenes (also known as olefins) hydrocarbon with at least one carbon-to-carbon double bond.

3.2.7.1 *Discussion*—In the context of this method, olefins are the result of the sum of alpha olefins, other mono-olefins, conjugated diolefins, non-conjugated diolefins, and cyclic olefins.

3.2.8 *polyaromatic hydrocarbons, n*—all hydrocarbon compounds containing two or more aromatic rings, including diaromatics and tri plus aromatics.

3.2.9 *relative response factor, n—in vacuum ultraviolet spectroscopy*, the relative response factor for a given compound is calculated from the compound's absorption cross section (expressed in cm^2/molecule) and methane's cross section.

3.2.9.1 *Discussion*—The absorption cross section is averaged over the 125 nm to 240 nm wavelength region.

3.2.9.2 *Discussion*—A compound's relative response factor is a function of the type and number of chemical bonds.

3.2.9.3 *Discussion*—A compound's relative response factor is relative to the response of methane, which is taken to have a relative response factor of 1.

3.2.10 *response area, n*—generally refers to a response summed over a given time interval and has units of absorbance units (AU).

3.2.10.1 *Discussion*—A time factor necessary to convert a response area to a true mathematical area cancels out of all critical calculations and is omitted.

3.2.11 *styrenes, n*—the chemical compound styrene CAS# 100-42-5 and alkyl-substituted styrenes.

3.2.11.1 *Discussion*—Styrenes may be attributed to polystyrene in the waste plastic feed.

3.2.12 *tri plus aromatic hydrocarbons, n*—hydrocarbon compounds containing three aromatic rings; this group includes phenanthrene, anthracene, and alkylated derivatives of these hydrocarbons.

3.2.13 *waste plastic process oil, n*—liquids from solid waste plastic produced by industrial processes such as pyrolysis, thermal cracking or chemical decomposition, depolymerization, which may include catalysis.

3.2.13.1 *Discussion*—Waste plastic used to produce WPPO

[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.