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.

Designation: D6443 – 14 (Reapproved 2019)$^{\varepsilon 1}$

Standard Test Method for Determination of Calcium, Chlorine, Copper, Magnesium, Phosphorus, Sulfur, and Zinc in Unused Lubricating Oils and Additives by Wavelength Dispersive X-ray Fluorescence Spectrometry (Mathematical Correction Procedure)[1]

This standard is issued under the fixed designation D6443; 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—Subsection 7.5.2 was editorially corrected in July 2019.

1. Scope

1.1 This test method covers the determination of calcium, chlorine, copper, magnesium, phosphorus, sulfur, and zinc in unused lubricating oils, additives, and additive packages by wavelength dispersive X-ray fluorescence spectrometry. Matrix effects are handled with mathematical corrections.

1.2 For each element, the upper limit of the concentration range covered by this test method is defined by the highest concentration listed in Table 1. Samples containing higher concentrations can be analyzed following dilution.

1.3 For each element, the lower limit of the concentration range covered by this test method can be estimated by the limit of detection (LOD)[2] (see also 40 CFR 136 Appendix B) or limit of quantification (LOQ),[2] both of which can be estimated from S_r, the repeatability standard deviation. LOD and LOQ values, determined from results obtained in the interlaboratory study on precision, are listed in Table 2.

1.3.1 LOD and LOQ are not intrinsic constants of this test method. LOD and LOQ depend upon the precision attainable by a laboratory when using this test method.

1.4 This test method uses regression software to determine calibration parameters, which can include influence coefficients (that is, interelement effect coefficients) (Guide E1361), herein referenced as alphas. Alphas can also be determined from theory using relevant software.

1.5 Setup of this test method is intended for persons trained in the practice of X-ray spectrometry. Following setup, this test method can be used routinely.

1.6 The values stated in either SI units or angstrom (Å) units are to be regarded separately as 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.*

2. Referenced Documents

2.1 *ASTM Standards:*[3]

D1552 Test Method for Sulfur in Petroleum Products by High Temperature Combustion and Infrared (IR) Detection or Thermal Conductivity Detection (TCD)

D4057 Practice for Manual Sampling of Petroleum and Petroleum Products

D4177 Practice for Automatic Sampling of Petroleum and Petroleum Products

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

D4628 Test Method for Analysis of Barium, Calcium, Magnesium, and Zinc in Unused Lubricating Oils by Atomic Absorption Spectrometry

D4927 Test Methods for Elemental Analysis of Lubricant and Additive Components—Barium, Calcium, Phosphorus, Sulfur, and Zinc by Wavelength-Dispersive X-Ray Fluorescence Spectroscopy

D4951 Test Method for Determination of Additive Elements

[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 D02.03 on Elemental Analysis.

Current edition approved May 1, 2019. Published July 2019. Originally approved in 1999. Last previous edition approved in 2014 as D6443 – 14. DOI: 10.1520/D6443-14R19E01.

[2] *Analytical Chemistry*, Vol 55, pp. 2210–2218.

[3] 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.

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