



Designation: D8322 – 20

Standard Test Method for Determination of Elements in Residual Fuels and Crude Oils by Microwave Plasma Atomic Emission Spectroscopy (MP-AES)¹

This standard is issued under the fixed designation D8322; 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 the determination of metals and other elements in residual fuel and crude oil by microwave plasma atomic emission spectroscopy (MP-AES). The specific elements within the scope of this method are V, Ni, Ca, Na, Al, Si, Zn, P, and S for residual fuel oil and Fe, V, Ni, Ca, Na, K, and S for crude oils.

1.2 Method working range:
high expected concentration limit = highest ILS sample mean
low expected concentration limit = lowest ILS sample mean if:

(1) lowest ILS sample mean – $R_{\text{lowest ILS sample mean}} > 0$;
otherwise it is determined by solving for X using the following equation:

(2) $X - R_x = \text{coarsest resolution, determined by } 0.5 \cdot \sigma_{r \text{ lowest ILS sample mean}}$

Crude Oil:

Element	Method Working Range (expected mg/kg)
Iron	0.70 to 161.02
Vanadium	2.88 to 417.50
Nickel	0.36 to 107.66
Calcium	5.41 to 96.78
Sodium	1.18 to 97.13
Potassium	7.01 to 63.83
Sulfur	1059 to 35194

Residual Fuel Oil:

Element	Method Working Range (expected mg/kg)
Vanadium	3.88 to 370.09
Nickel	1.47 to 96.68
Calcium	4.41 to 102.01
Sodium	2.80 to 112.67
Aluminum	4.13 to 154.12
Silicon	5.99 to 237.56
Zinc	2.75 to 102.46
Sulfur	1314 to 30134

1.3 This test method uses soluble metals in organic solvents for calibration and does not purport to quantitatively determine insoluble particulates. Analytical results are particle size

dependent, and particles larger than a few micrometers may cause results to appear low

1.4 Elements present at mass fractions above the upper limit of the calibration curves can be determined with additional appropriate dilutions. Elements shall be measured at the wavelengths presented in [Table 1](#).

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

1.6 *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.*

1.7 *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

[D1298 Test Method for Density, Relative Density, or API Gravity of Crude Petroleum and Liquid Petroleum Products by Hydrometer Method](#)

[D1548 Test Method for Vanadium in Heavy Fuel Oil¹ \(Withdrawn 1997\)³](#)

[D4052 Test Method for Density, Relative Density, and API Gravity of Liquids by Digital Density Meter](#)

[D4175 Terminology Relating to Petroleum Products, Liquid Fuels, and Lubricants](#)

[D5708 Test Methods for Determination of Nickel, Vanadium, and Iron in Crude Oils and Residual Fuels by](#)

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.

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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.