



Standard Test Methods for Instrumental Determination of Carbon, Hydrogen, and Nitrogen in Petroleum Products and Lubricants¹

This standard is issued under the fixed designation D 5291; 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 These test methods cover the instrumental determination of carbon, hydrogen, and nitrogen in laboratory samples of petroleum products and lubricants. Values obtained represent the total carbon, the total hydrogen, and the total nitrogen.

1.2 These test methods are applicable to samples such as crude oils, fuel oils, additives, and residues for carbon and hydrogen and nitrogen analysis. These test methods were tested in the concentration range of at least 75 to 87 mass % for carbon, at least 9 to 16 mass % for hydrogen, and < 0.1 to 2 mass % for nitrogen.

1.3 The nitrogen test method is not applicable to light materials or those containing < 0.75 mass % nitrogen, or both, such as gasoline, jet fuel, naphtha, diesel fuel, or chemical solvents.

1.4 These test methods are not recommended for the analysis of volatile materials such as gasoline, gasoline-oxygenate blends, or gasoline type aviation turbine fuels.

1.5 The results of these tests can be expressed as mass % carbon, hydrogen or nitrogen.

1.6 The values stated in SI units are to be regarded as the 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 and health practices and determine the applicability of regulatory limitations prior to use.*

2. Referenced Documents

2.1 ASTM Standards:

D 4057 Practice for Manual Sampling of Petroleum and Petroleum Products²

D 4177 Practice for Automatic Sampling of Petroleum and Petroleum Products²

3. Summary of Test Methods

3.1 In these test methods, carbon, hydrogen, and nitrogen are determined concurrently in a single instrumental procedure.

With some systems, the procedure consists of simply weighing a portion of the sample, placing the portion in the instrument, and initiating the (subsequently automatic) analytical process. In other systems, the analytical process, to some degree, is manually controlled.

3.2 The actual process can vary substantially from instrument to instrument, since a variety of means can be utilized to effect the primary requirements of the test methods. All satisfactory processes provide for the following:

3.2.1 The conversion of the subject materials (in their entirety) to carbon dioxide, water vapor, and elemental nitrogen, respectively, and

3.2.2 The subsequent, quantitative determination of these gases in an appropriate gas stream.

3.3 The conversion of the subject materials to their corresponding gases takes place largely during combustion of the sample at an elevated temperature in an atmosphere of purified oxygen. Here, a variety of gaseous materials are produced, including the following:

3.3.1 Carbon dioxide from the oxidation of organic and elemental carbon,

3.3.2 Hydrogen halides from organic halides (and organic hydrogen, as required),

3.3.3 Water vapor from the oxidation of (the remaining) organic hydrogen and the liberation of moisture,

3.3.4 Nitrogen and nitrogen oxides from the oxidation of organic nitrogen, and

3.3.5 Sulfur oxides from the oxidation of organic sulfur. In some systems, sulfurous and sulfuric acids can also be obtained from a combination of the sulfur oxides and the water vapor.

3.4 There are several accepted ways of isolating the desired gaseous products and quantitatively determining them. These are as follows:

3.4.1 *Test Method A³*—From the combustion product gas stream, oxides of sulfur are removed with calcium oxide in the secondary combustion zone. A portion of the remaining mixed gases is carried by helium gas over a hot copper train to remove oxygen, and reduce NO_x to N₂, over NaOH to remove CO₂, and over magnesium perchlorate to remove H₂O. The remaining elemental nitrogen is measured by the thermal conductivity

¹ These test methods are under the jurisdiction of ASTM Committee D-2 on Petroleum Products and Lubricants and are the direct responsibility of Subcommittee D02.03.0B on Spectrometric Methods.

Current edition approved April 10, 1996. Published June 1996. Originally published as D 5291 – 92. Last previous edition D 5291 – 92.

² *Annual Book of ASTM Standards*, Vol 05.02.

³ Leco CHN-600 instrument has been found satisfactory for the analyses in Test Method A, and is available from Leco Corporation, 3000 Lakeview Ave., St. Joseph, MI 49085.