Designation: D6522 – 20

Standard Test Method for Determination of Nitrogen Oxides, Carbon Monoxide, and Oxygen Concentrations in Emissions from Natural Gas-Fired Reciprocating Engines, Combustion Turbines, Boilers, and Process Heaters Using Portable Analyzers[1]

This standard is issued under the fixed designation D6522; 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 nitrogen oxides (NO and NO_2), carbon monoxide (CO), and oxygen (O_2) concentrations in controlled and uncontrolled emissions from natural gas-fired reciprocating engines, combustion turbines, boilers, and process heaters using portable analyzers with electrochemical sensors. Due to the inherent cross sensitivities of the electrochemical cells, this test method should not be applied to other pollutants or emission sources without a complete investigation of possible analytical interferences and a comparative evaluation with EPA test methods.

1.1.1 The procedures and specifications of this test method were originally developed during laboratory and field tests funded by the Gas Research Institute (GRI).[2] Comparative emission tests were conducted only on natural gas-fired combustion sources. Subsequently, the U.S. Environmental Protection Agency (EPA) sponsored Environmental Technology Verification (ETV) program conducted further evaluations of electrochemical cell analyzers, which included laboratory tests and field tests on natural gas and diesel-fueled generators. The EPA has reviewed the ETV test results, published additional information, and provided technical input that has been considered in the update of this test method.[3]

1.2 This test method contains notes that are explanatory and are not part of the mandatory requirements of the standard.

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

1.4 *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.*

1.5 *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:*[4]

D1356 Terminology Relating to Sampling and Analysis of Atmospheres

2.2 *EPA Methods from 40 CFR Part 60, Appendix A:*[5]

Method 3A Determination of Oxygen and Carbon Dioxide Concentrations in Emissions from Stationary Sources (Instrumental Analyzer Procedure)

Method 7E Determination of Nitrogen Oxides Emissions from Stationary Sources (Instrumental Analyzer Procedure)

Method 10 Determination of Carbon Monoxide Emissions from Stationary Source

Method 20 Determination of Nitrogen Oxides, Sulfur Dioxide, and Diluent Emissions from Stationary Gas Turbines

2.3 *EPA Methods from 40 CFR Part 63, Appendix A:*[5]

Method 301 Field Validation of Pollutant Measurement Methods from Various Waste Media

[1] This test method is under the jurisdiction of ASTM Committee D22 on Air Quality and is the direct responsibility of Subcommittee D22.03 on Ambient Atmospheres and Source Emissions.

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[2] Juneau, P. Peeler, J. W., "Development of an Electrochemical Cell Emission Analyzer Test Method," Gas Research Institute Topical Report prepared by Emission Monitoring Inc., GRI-96/0008, July 1997.

[3] Shanklin, S., Wesson, K., and Kellar, P., "Evaluation of Portable Analyzers for Use in Quality Assuring Predictive Emission Monitoring Systems for NO_x," prepared by The Cadmus Group, EPA Contract No. 68-W-03-033, September 2004.

[4] 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.

[5] Available from U.S. Government Printing Office, Superintendent of Documents, 732 N. Capitol St., NW, Washington, DC 20401-0001, http://www.access.gpo.gov.

2.4 *EPA Methods from 40 CFR Part 75, Appendix H:*[6]
Protocol G1 Procedures
Protocol G2 Procedures

3. Terminology

3.1 *Definitions:*

3.1.1 For terminology relevant to this test method, see Terminology D1356.

3.2 *Definitions of Terms Specific to This Standard:*

3.2.1 *measurement system, n*—total equipment required for the determination of gas concentration. The measurement system consists of the following major subsystems:

3.2.1.1 *data recorder, n*—a strip chart recorder, computer, or digital recorder for recording measurement data.

3.2.1.2 *electrochemical cell, n*—that portion of the system that senses the gas to be measured and generates an output proportional to its concentration, or any cell that uses diffusion-limited oxidation and reduction reactions to produce an electrical potential between a sensing electrode and a counter electrode.

3.2.1.3 *external interference gas scrubber, n*—device filled with scrubbing agent used to remove interfering compounds upstream of some electrochemical cells.

3.2.1.4 *sample interface, n*—that portion of a system used for one or more of the following: sample acquisition, sample transport, sample conditioning, or protection of the electrochemical cells from particulate matter and condensed moisture.

3.2.2 *initial NO cell temperature, n*—temperature of the NO cell that is recorded during the most recent pretest calibration error check.

3.2.2.1 *Discussion*—Since the NO cell can experience significant zero drift with temperature changes in some situations, the temperature must be monitored if the analyzer does not display negative concentration results. Nitric oxide cell temperature monitoring is not required if the analyzer can display negative concentrations. Drift due to temperature changes will be identified in the post calibration check for these analyzers where negative concentrations will be observed.

3.2.3 *interference check, n*—method of quantifying analytical interferences from components in the stack gas other than the analyte.

3.2.4 *linearity check, n*—method of demonstrating the ability of a gas analyzer to respond consistently over a range of gas concentrations.

3.2.4.1 *Discussion*—Linearity checks are not required for analyzers where the electrochemical sensor manufacturer has published data demonstrating linearity through the sensor range.

3.2.5 *nominal range, n*—range of concentrations over which each cell is operated (25 % to 125 % of upscale calibration gas value).

3.2.5.1 *Discussion*—Several nominal ranges may be used for any given cell as long as the linearity and stability check results remain within specification.

3.2.6 *response time, n*—amount of time required for the measurement system to display 95 % of a step change in gas concentration on the data recorder.

3.2.7 *upscale calibration error, n*—difference between the gas concentration exhibited by the gas analyzer and the known concentration of the upscale calibration gas.

3.2.8 *upscale calibration gas, n*—known concentration of a gas in an appropriate diluent gas.

3.2.9 *stability check, n*—method of demonstrating that an electrochemical cell operated over a given nominal range provides a stable response and is not significantly affected by prolonged exposure to the analyte.

3.2.10 *stability time, n*—elapsed time from the start of the gas injection to the start of the 15-min or 30-min stability check period, as determined during the stability check.

3.2.11 *zero calibration error, n*—gas concentration exhibited by the gas analyzer in response to zero-level calibration gas.

4. Summary of Test Method

4.1 A gas sample is continuously extracted from a duct and conveyed to a portable analyzer for determination of NO, NO_2, CO, and O_2 gas concentrations using electrochemical cells. Analyzer design specifications, performance specifications, and test procedures are provided to ensure reliable data.

4.2 Additions to or modifications of some vendor-supplied analyzers (for example, sample systems which chill the sample at the probe and transports cold, dry gas to the analyzer, heated sample line, flow meters, and so forth) may be necessary to meet the design specifications of this test method.

5. Significance and Use

5.1 The results of this test method may be used to determine nitrogen oxides and carbon monoxide emission concentrations from natural gas combustion at stationary sources.

5.2 This test method may also be used to monitor emissions during short-term emission tests or periodically in order to optimize process operation for nitrogen oxides and carbon monoxide control.

6. Interferences

6.1 NO and NO_2 can interfere with CO concentration measurements, and NO_2 can interfere with NO concentration measurements. The interference effects for the CO and NO emission measurements are quantified in 9.2 and shall not exceed 5 % of the measurement.

7. Apparatus

7.1 The minimum detectable limit depends on the nominal range of the electrochemical cell, calibration drift, and signal-to-noise ratio of the measurement system. For a well-designed system, the minimum detectable limit should be less than 2 % of the nominal range.

[6] EPA 600/R-12/531, EPA Traceability Protocol for Assay and Certification of Gaseous Calibration Standards, May 2012. Available from https://www.epa.gov/ord.