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

## 1. APPLICABILITY AND PRINCIPLE

**1.1 Applicability.** This method is applicable to the determination of oxygen  $(O_2)$  and carbon dioxide (GO) concentrations in emissions from stationary sources only when specified within the regulations.

**1.2 Principle.** A sample is continuously extracted from the effluent stream: a portion of the sample stream is conveyed to an instrumental analyzer(s) for determination of  $O_2$  and  $CO_2$  concentration(s). Performance specifications and test procedures are provided to ensure reliable data.

## 2. RANGE AND SENSITIVITY

Same as in Method 6C, Sections 2.1 and 2.2, except that the span of the monitoring system shall be selected such that the average  $O_2$  or CQ concentration is not less than 20 percent of the span.

### 3. DEFINITIONS

**3.1 Measurement System.** The total equipment required for the determination of the  $O_2$  or CQ concentration. The measurement system consists of the same major subsystems as defined in Method 6C, Sections 3.1.1, 3.1.2, and 3.1.3.

3.2 Span, Calibration Gas, Analyzer Calibration Error, Sampling System Bias, Zero Drift, Calibration Drift, Response Time, and Calibration Curve. Same as in Method 6C, Sections 3.2 through 3.8, and 3.10.

**3.3 Interference Response.** The output response of the measurement system to a component in the sample gas, other than the gas component being measured.

### 4. MEASUREMENT SYSTEM PERFORMANCE SPECIFICATIONS

Same as in Method 6C, Sections 4.1 through 4.4.

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### 5. APPARATUS AND REAGENTS

**5.1 Measurement System.** Any measurement system for  $O_2$  or  $CO_2$  that meets the specifications of this method. A schematic of an acceptable measurement system is shown in Figure 6C-1 of Method 6C. The essential components of the measurement system are described below:

**5.1.1 Sample Probe.** A leak-free probe of sufficient length to traverse the sample points.

**5.1.2 Sample Line.** Tubing to transport the sample gas from the probe to the moisture removal system. A heated sample line is not required for systems that measure the  $0_2$  or CQ concentration on a dry basis, or transport dry gases.

5.1.3 Sample Transport Line, Calibration Valve Assembly, Moisture Removal System, Particulate Filter, Sample Pump, Sample Flow Rate Control, Sample Gas Manifold, and Data Recorder. Same as in Method 6C, Sections 5.1.3 through 5.1.9, and 5.1.11, except that the requirements to use stainless steel, Teflon, and nonreactive glass filters do not apply.

**5.1.4 Gas Analyzer.** An analyzer to determine continuously the  $O_2$  or  $CO_2$  concentration in the sample gas stream. The analyzer must meet the applicable performance specifications of Section 4. A means of controlling the analyzer flow rate and a device for determining proper sample flow rate (e.g., precision rotameter, pressure gauge downstream of all flow controls, etc.) shall be provided at the analyzer. The requirements for measuring and controlling the analyzer flow rate are not applicable if data are presented that demonstrate the analyzer is insensitive to flow variations over the range encountered during the test.

**5.2 Calibration Gases.** The calibration gases for  $CO_2$  analyzers shall be  $CO_2$  in  $N_2$  or  $CO_2$  in air. Alternatively, CQ/SQ, Q/SQ, or Q/CQ/SQ gas mixtures in  $N_2$  may be used. Three calibration gases, as specified in Sections 5.3.1 through 5.3.4 of Method 6C, shall be used. For  $O_2$  monitors that cannot analyze zero gas, a calibration gas concentration equivalent to less than 10 percent of the span may be used in place of zero gas.

#### 6. MEASUREMENT SYSTEM PERFORMANCE TEST PROCEDURES

Perform the following procedures before measurement of emissions (Section 7).

**6.1** Calibration Concentration Verification. Follow Section 6.1 of Method 6C, except if calibration gas analysis is required, use Method 3 and change the acceptance criteria for agreement among Method 3 results to 5 percent (or 0.2 percent by volume, whichever is greater).

**6.2 Interference Response.** Conduct an interference response test of the analyzer prior to its initial use in the field. Thereafter, recheck the measurement system if changes are made in the instrumentation that could alter

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the interference response (e.g., changes in the type of gas detector). Conduct the interference response in accordance with Section 5.4 of Method 20.

6.3 Measurement System Preparation, Analyzer Calibration Error, Response Time, and Sampling System Bias Check. Follow Sections 6.2 through 6.4 of Method 6C.

### 7. EMISSION TEST PROCEDURE

7.1 Selection of Sampling Site and Sampling Points. Select a measurement site and sampling points using the same criteria that are applicable to tests performed using Method 3.

7.2 Sample Collection. Position the sampling probe at the first measurement point, and begin sampling at the same rate as that used during the response time test. Maintain constant rate sampling (i.e., ±10 percent) during the entire run. The sampling time per run shall be the same as for tests conducted using Method 3 plus twice the average system response time. For each run, use only those measurements obtained after twice the response time of the measurement system has elapsed to determine the average effluent concentration.

7.3 Zero and Calibration Drift Test. Follow Section 7.4 of Method 6C.

### 8. QUALITY CONTROL PROCEDURES

The following quality control procedures are recommended when the results of this method are used for an emission rate correction factor, or excess air determination. The tester should select one of the following options for validating measurement results:

8.1 If both  $O_2$  and CQ are measured using Method 3A, the procedures described in Section 4.4 of Method 3 should be followed to validate the  $O_2$  and  $CO_2$  measurement results.

8.2 If only  $O_2$  is measured using Method 3A, measurements of the sample stream  $CO_2$  concentration should be obtained at the sample by-pass vent discharge using an Orsat or Fyrite analyzer, or equivalent. Duplicate samples should be obtained concurrent with at least one run. Average the duplicate Orsat or Fyrite analysis results for each run. Use the average  $CO_2$  values for comparison with the  $O_2$  measurements in accordance with the procedures described in Section 4.4 of Method 3.

8.3 If only  $CO_2$  is measured using Method 3A, concurrent measurements of the sample stream  $CO_2$  concentration should be obtained using an Orsat or Fyrite analyzer as described in Section 8.2. For each run, differences greater than 0.5 percent between the Method 3A results and the average of

the duplicate Fyrite analysis should be investigated.

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### 9. EMISSION CALCULATION

**9.1** For all  $CO_2$  analyzers, and for Q analyzers that can be calibrated with zero gas, follow Section 8 of Method 6C, except express all concentrations as percent, rather than ppm.

**9.2** For  $O_2$  analyzers that use a low-level calibration gas in place of a zero gas, calculate the effluent gas concentration using Equation 3A-1.

$$C_{gas} = \frac{C_{ma} - C_{oa}}{C_{m} - C_{o}} (C - C_{m}) + C_{ma}$$
 Eq. 3A-1

Where:

 $C_{mas}$  = Effluent gas concentration, dry basis, percent.

 $C_{ma}$  = Actual concentration of the upscale calibration gas, percent.

 $C_{\mbox{\tiny oa}}$  = Actual concentration of the low-level calibration gas, percent.

- $C_m$  = Average of initial and final system calibration bias check responses for the upscale calibration gas, percent.
- $\rm C_{o}$  = Average of initial and final system calibration bias check responses for the low level gas, percent.

C = Average gas concentration indicated by the gas analyzer, dry basis, percent.

### 10. BIBLIOGRAPHY

Same as in Bibliography of Method 6C.