# Source Test Procedure **ST-24**

# TANK SAMPLING FOR ORSAT ANALYSIS (CO, CO<sub>2</sub>, O<sub>2</sub>)

## REF: Regulations 6-310.1, 8-1-110.3, 10-3-301, 9-3-301 through 9-3-304

### 1. APPLICABILITY

1.1 This procedure is used to quantify the emissions of carbon monoxide, carbon dioxide and oxygen contents of stack gases. It is an acceptable alternate to ST-5, ST-6, and ST-14.

#### 2. PRINCIPLE

2.1 Stack gases are drawn at a constant rate into an evacuated stainless steel tank. A desiccant is used to dry the gases before entering the tank. After testing, the tank is positively pressurized with a known amount of dry nitrogen. The tank contents are then analyzed with an Orsat analyzer, and the results are corrected back to pre-dilution conditions.

### 3. RANGE

- 3.1 The minimum measurable concentration of CO,  $CO_2$  or  $O_2$  is 0.2%.
- 3.2 The procedure is usable for gases up to 100% CO, CO  $_2$  or O $_2$ .

#### 4. INTERFERENCE

4.1 SO<sub>2</sub> interferes with CO<sub>2</sub> determination.

#### 5. APPARATUS

- 5.1 Tank. Use a stainless steel tank, 8-liter capacity or larger, fitted with a stainless steel flow-controlling valve and a vacuum gauge.
- 5.2 Flowmeter. Use a rotameter capable of measuring low sampling rates.
- 5.3 Desiccant Bed. Use Drierite, or equivalent, or sufficient capacity to dry a volume of sample equal to the tank volume.
- 5.4 Probe. The probe is constructed of either stainless steel or glass.
- 5.5 Connections. All flexible tubing connections must be leak free.
- 5.6 Purging Apparatus. Use a squeeze bulb with check valves to purge the sample lines with stack gases prior to sampling, as shown in Figure 24-1.
- 5.7 Manometer. Use a differential manometer with a range of -30 to +20 inches Hg.
- 5.8 Barometer. Use a temperature compensated aneroid type with a range of 28.0 to 31.0 inches Hg.

### 6. PRE-TEST PROCEDURES

6.1 Prior to the field test, evacuate and seal the tank. If, after a period of not less than two hours, the vacuum gauge indicates a leak, do not use the tank.

- 6.2 If no leak is found, record the evacuated pressure (gauge), the ambient temperature, and barometric pressure at the time of evacuation.
- 6.3 In the field, assemble the sampling apparatus as shown in Figure 24-1. Purge the sampling train until stack gas has completely replaced ambient air. Then remove purging apparatus from the sampling system.

Probe -n-S 0 U Vinyl R C Tubing Purge Bulb Shutoff Rotameter Е Check Valves Flow Control Vacuum and Shutoff Gauge 🕥 Desiccant Evacuated Cylinder

# Figure 24-1 Sampling for Orsat Analysis

### 7. SAMPLING

- 7.1 Sample at a constant rate slow enough to fill the evacuated cylinder in approximately 30 minutes.
- 7.2 For batch processes sample at a constant rate slow enough to fill the evacuated cylinder in approximately 30 minutes or 90% of the batch process time, whichever is less.
- 7.3 When the tank is full, seal it for later evaluation.
- 7.4 Take three consecutive samples if feasible.

#### 8. **POST-TEST PROCEDURES**

8.1 Allow the tank to equilibrate at or ne ar the ambient temperature at which it was evacuated. Then record the pressure of its contents and the barometric pressure.

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8.2 Pressurize the tank to at least 10 inches of mercury with dry oxygen-free Wait at least ten minutes before reading and recording the nitrogen. pressure.

#### 9. **ANALYTICAL PROCEDURES**

- 9.1 The tank contents are analyzed for oxygen, carbon monoxide and/or carbon dioxide by the Orsat method. Operation of the analysis apparatus shall follow manufacturer's instructions.
- 9.2 The tank contents are analyzed until successive analyses are constant within .2% (absolute). The constant values shall be reported as the results of the analysis.

#### 10. CALCULATIONS

10.1 Tank dilution correction factor:

$$F = \frac{P_3 + P_{BF}}{(P_2 + P_{BF}) - (P_1 + P_{B1})}$$

where:

- F Correction factor =
- P<sub>1</sub> P<sub>2</sub> Residual pressure after evacuation (gauge) =

= Pressure after sampling, (gauge)

P<sub>3</sub> = Pressure after addition of nitrogen (gauge)

- Barometric pressure at the time of evacuation PBI =
- Barometric pressure at time of pressurization PBF =
- Multiply by the factor determined in 10.1, the Orsat analytic results from 10.2 Section 9.

#### 11. REPORTING

11.1 These values are determined as auxiliary data for other procedures and shall be reported with those test results.