

SEMI C3.23-1000 (Withdrawn 1104) STANDARD FOR OXYGEN (O₂), 99.98% QUALITY

This Standard was technically approved by the Gases Global Technical Committee. This edition was approved for publication by the global Audits and Reviews Subcommittee on July 11, 2004. Available at www.semi.org in November 2004; originally published in 1984; previously published in 1995.

NOTICE: This Document was balloted and approved for withdrawal in 2004.

1 Description

1.1 Oxygen is a colorless, odorless, and oxidizing gas. It supports combustion.

2 Specifications

QUALITY: 99.98%

<i>Impurities</i>	<i>Maximum Acceptable Level (ppm)^{#1}</i>
Argon (Ar)	100
Carbon Monoxide (CO)	1
Carbon Dioxide (CO ₂)	1
Krypton (Kr)	10
Nitrogen (N ₂)	30
Nitrous Oxide (NO)	1
Particles	#2
Total Hydrocarbons expressed as Methane (THC)	1
Water (H ₂ O) (v/v)	1
TOTAL IMPURITIES	146

#1 An analysis of significant figures has not been considered. The number of significant figures will be based on analytical accuracy and the precision the provided procedure.

#2 To be determined between supplier and user.

3 Physical Constants (for information only)

	<i>Metric Units</i>	<i>US Units</i>
Molecular weight	31.999	31.999
Boiling point at 1 atm	−183°C	−297.4°F
Density of gas at 25°C (77°F) and 1 atm	1.309 kg/m ³	0.082 lb/ft ³
Specific gravity of gas at 21.1°C (70°F) and 1 atm (air = 1)	1.1049	1.1049
Density of liquid at boiling point	1142 kg/m ³	71.27 lb/ft ³

4 Analytical Procedures (See Notes 1, 2)

4.1 *Argon* — This procedure is for the determination of argon using a gas chromatograph with a thermal conductivity detector.

4.1.1 *Detection Limit* — 25 ppm (mole/mole).

4.1.2 *Instrument Parameters*

4.1.2.1 *Column* — 3.6 m (12 ft.) by 3.2 mm (1/8 in.) stainless steel tubing packed with molecular sieve 5A, 60/80 mesh, washed to remove fines and activated at 300°C for 24 hours or equivalent.

4.1.2.2 *Carrier Flow* — 45 mL/min helium.

4.1.2.3 *Sample Volume* — 1 mL to 3 mL.

4.1.2.4 *Temperatures*

- Detector — 40°C.
- Column — -50°C.

4.1.3 *Calibration Standard* — 50 ppm to 150 ppm (mole/mole) argon, balance helium.

4.1.4 *Operating Procedure*

4.1.4.1 With the valve in Position A, load the sample loop. Switch the valve to Position B to inject the sample into the column. After the argon has been detected, switch the valve back to Position A to backflush the oxygen from the column. Record the peak area and retention time.

4.1.4.2 Inject oxygen sample to be tested in the same manner as in ¶ 4.1.4.1. Record the retention times and peak areas.

4.1.4.3 Repeat ¶ 4.1.4.1.

4.1.4.4 Calculate the concentration of argon in the sample, using the formula below. The result may not exceed the specification § 2 of this Standard.

$$\frac{\text{Sample Peak Area}}{\text{Standard Peak Area}} \times \frac{\text{Concentration of Standard}}{\text{Concentration of Sample}} = \text{Concentration of Sample} \quad (1)$$

4.2 *Carbon Monoxide* — This procedure is for the determination of carbon monoxide using dual beam optical nondispersive infrared spectrophotometry.

4.2.1 *Detection Limit* — 0.2 ppm (mole/mole)

4.2.2 *Instrument Parameters*

4.2.2.1 *Detector* — ‘Luft’ type or equivalent.

4.2.2.2 *10 Inch Infrared Gas Cell* — or gas cell with equivalent sensitivity.

4.2.2.3 *Sample Cell Pressure* — 200 psig for full scale range 0 ppm to 20 ppm carbon monoxide or appropriate pressure recommended by the cell manufacturer.

4.2.2.4 *Sample Flowrate* — 500 cc/minute or as specified by the instrument manufacturer.

4.2.2.5 *Wavelength* — 4.75 micrometers (4750 nm).

4.2.2.6 *Wavenumber* — 2100 cm⁻¹.

4.2.3 *Calibration Standard* — 5 ppm (mole/mole) carbon monoxide, balance oxygen.

4.2.4 *Operating Procedure* — See Notes 5, 6.

4.2.4.1 Open the zero gas (pre-purified nitrogen or certified pure oxygen, independently measured to be less than 0.1 ppm CO) cylinder valve. Open valve V1, close valves V2 and V3. Flow the gas through the system and adjust the back pressure regulator to 200 psig as shown on gauge G. Adjust the flowrate on the flowmeter to 1000 cc/minute by

adjusting valve V1. After a constant readout is observed, adjust the zero control knob of the analyzer to set the absorbance output to read zero.

4.2.4.2 Open the calibration gas standard cylinder valve. Close V1 and V2, and open valve V3. Flow the calibration gas through the system and adjust the back pressure regulator to 200 psig. Adjust the flowrate on the flowmeter to 1000 cc/minute. After a constant readout is observed, record the absorbance of the calibration standard, if the instrument indicates absorbance directly. If the instrument indicates concentration, adjust the span control to read the concentration of carbon monoxide in the calibration gas.

4.2.4.3 Introduce the oxygen sample into the analyzer by closing valves V1 and V3, opening valve V4 and slowly opening valve V2 until the flowrate on the flowmeter is 1000 cc/minute. Adjust the back pressure regulator to 200 psig. If the instrument indicates absorbance, read the absorbance of the sample and calculate the quantity of carbon monoxide, using the formula below. If the instrument indicates concentration, record the concentration. The results may not exceed the specification in § 2 of this Standard.

$$\frac{\text{Measured Absorbance of Sample}}{\text{Measured Absorbance of Standard}} \times \frac{\text{Concentration of Standard}}{\text{Concentration of Sample}} = \text{Concentration of Sample} \quad (2)$$

4.3 *Carbon Dioxide* — This procedure is for the determination of carbon dioxide using dual beam optical non-dispersive infrared spectrophotometry.

4.3.1 *Detection Limit* — 0.05 ppm (mole/mole).

4.3.2 *Instrument Parameters*

4.3.2.1 *Detector* — ‘Luft’ type or equivalent.

4.3.2.2 *10 Inch Infrared Gas Cell* — Or gas cell with equivalent sensitivity.

4.3.2.3 *Sample Cell Pressure* — 100 psig for full scale range 0 ppm to 5 ppm carbon dioxide; 200 psig for full scale range of 0 ppm to 2.5 ppm carbon dioxide or appropriate pressure as recommended by cell manufacturer.

4.3.2.4 *Sample Flowrate* — 500 cc/minute or as specified by the instrument manufacturer.

4.3.2.5 *Wavelength* — 4.4 micrometers (4400 nm).

4.3.2.6 *Wavenumber* — 2250 cm⁻¹.

4.3.3 *Calibration Standard* — 5 ppm (mole/mole) carbon dioxide, balance oxygen.

4.3.4 *Operating Procedure* — See Notes 5 and 6.

4.3.4.1 Open the zero gas (pre-purified nitrogen or pure oxygen, independently measured to be less than 0.1 ppm CO₂) cylinder valve. Open valve V1, close valves V2 and V3. Flow the gas through the system and adjust the back pressure regulator to 100 psig as shown on gauge G. Adjust the flowrate on the flowmeter to 1000 cc/minute by adjusting valve V1. After a constant readout is observed, adjust the zero control knob of the analyzer to set the absorbance output to read zero.

4.3.4.2 Open the calibration gas standard cylinder valve. Close V1 and V2, and open valve V3. Flow the calibration gas through the system and adjust the back pressure regulator to 100 psig. Adjust the flowrate on the flowmeter to 1000 cc/minute. After a constant readout is observed, record the absorbance of the calibration standard, if the instrument indicates absorbance directly. If the instrument indicates concentration, adjust the span control to read the concentration of carbon dioxide in the calibration gas.

4.3.4.3 Introduce the oxygen sample into the analyzer by closing valves V1 and V3, opening valve V4 and slowly opening valve V2 until the flowrate on the flowmeter is 1000 cc/minute. Adjust the back pressure regulator to 100 psig. If the instrument indicates absorbance, read the absorbance of the sample and calculate the quantity of carbon dioxide, using the formula below. If the instrument indicates concentration, record the concentration. The results may not exceed the specification in § 2 of this Standard.

$$\frac{\text{Measured Absorbance of Sample}}{\text{Measured Absorbance of Standard}} \times \frac{\text{Concentration of Standard}}{\text{Concentration of Sample}} = \text{Concentration of Sample} \quad (3)$$