SEMI C3.20-92 (Reapproved 0999)
STANDARD FOR HELIUM (He), IN CYLINDERS, 99.9995% 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 April 15, 1999. Available at www.semi.org in September 1999; originally published in 1982; previously published in 1992.

1 Description

1.1 Helium is a rare gas or cryogenic liquid that is inert, colorless, odorless, and tasteless.

2 Specifications

QUALITY: 99.9995%

Impurities	*Maximum Acceptable Level (ppm)*[#1]
Carbon monoxide and carbon dioxide ($CO + CO_2$)	1
Nitrogen (N_2)	2
Oxygen (O_2)	0.5
Total Hydrocarbons expressed as Methane (THC)	0.5
Water (H_2O) (v/v)	0.5
TOTAL SPECIFIED IMPURITIES	4.5

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

3 Physical Constants (for information only)

	Metric Units	*US Units*
Molecular weight	4.003	4.003
Boiling point at 1 atm	−268.9°C	−452.0°F
Density of gas at 21.1°C (70°F) and 1 atm	0.1656 kg/m^3	0.01034 lb/ft^3
Specific gravity of gas at 21.1°C and 1 atm (air = 1)	0.138	0.138
Density of liquid at boiling point	124.9 kg/m^3	7.798 lb/ft^3

4 Analytical Procedures (See Notes 1, 2)

4.1 *Carbon Monoxide and Carbon Dioxide* — This procedure is for the determination of carbon monoxide and carbon dioxide in helium using a gas chromatograph with a flame ionization detector and methanizer.

4.1.1 *Detection Limit* — 100 ppb (mole/mole).

4.1.2 *Instrument Parameters*

4.1.2.1 Column:

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- Porapak T or Q, 3 m (9.8 ft.) by 3 mm (1/8 in.) ss; or
- Chromosorb 102, 2 m (6.6 ft.) by 3 mm ss; or equivalent.

4.1.2.2 Carrier Flow: 30 mL/min helium.

4.1.2.3 Sample Volume: 0.5 to 2.0 mL.

4.1.2.4 Temperatures:

- *Detector* — 280°C.
- *Column Oven* — 60°C.
- *Methanizer* — 350°C.

4.1.3 *Calibration Standards* — 1 to 10 ppm (mole/mole) carbon monoxide, 1 to 10 ppm (mole/mole) carbon dioxide, balance helium.

4.1.4 *Operating Procedure*

4.1.4.1 Inject the calibration standard into the column using a gas sampling valve. Record the retention times and peak areas. Order of elution is carbon monoxide, carbon dioxide.

4.1.4.2 Inject the sample to be tested in same manner as the calibration standard. Record the retention times and peak areas.

4.1.4.3 Repeat ¶ 4.1.4.1.

4.1.4.4 Compare the average peak areas of the calibration standard to that of the helium sample being tested. Calculate the concentrations of carbon monoxide and carbon dioxide, using the formula below. The result may not exceed the specification in § 2 of this Standard.

$$\frac{\text{Sample Peak Area}}{\text{Standard Peak Area}} \times \begin{matrix}\text{Concentration}\\ \text{of Standard}\end{matrix} = \begin{matrix}\text{Concentration}\\ \text{of Sample}\end{matrix} \qquad (1)$$

4.2 *Nitrogen* — This procedure is for the determination of nitrogen in helium using a gas chromatograph with a helium ionization detector.

4.2.1 *Detection Limit* — 500 ppb.

4.2.2 *Instrument Parameters*

4.2.2.1 Column: 5A molecular sieve, 1.9 m (6 ft.) by 3.2 mm (1/8 in.) ss, or equivalent.

4.2.2.2 Carrier Flow: 30 mL/min helium.

4.2.2.3 Sample Volume: 3.0 mL.

4.2.2.4 Temperatures:

- *Detector* — 125°C.
- *Column Temperature* — 65°C.

4.2.3 *Calibration Standard* — 5 to 15 ppm nitrogen in helium.

4.2.4 *Operating Procedure*

4.2.4.1 Inject the calibration standard into the column using a gas sampling valve. Record the retention time and peak area.

4.2.4.2 Inject the sample to be tested in same manner as the calibration standard. Record the retention time and peak area.

4.2.4.3 Repeat ¶ 4.2.4.1.

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