

SEMI C3.37-0701

SPECIFICATION FOR HEXAFLUOROETHANE (C₂F₆), 99.97% QUALITY

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1 Description

1.1 Hexafluoroethane is one of the most stable of all organic compounds. It is inert, colorless, nonflammable, odorless and tasteless.

2 Specifications

QUALITY: 99.97%

Impurities	Maximum Impurities Acceptable (ppm)*
Carbon Dioxide (CO ₂)	1
Carbon Monoxide (CO)	1
Nitrogen (N ₂)	100
Other Halogenated Hydrocarbons (CF ₃ Cl, CF ₃ H, CF ₂ HCl, C ₂ F ₅ Cl)	50
Oxygen (O ₂)	25
Water (H ₂ O) (v/v)	40
TOTAL LISTED IMPURITIES	217

*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 Chemical Specification

Total Acidity	0.1 ppmw max.
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4 Physical Constants (for information only)

	Metric Units	US Units
Molecular weight	138.01	138.01
Boiling point at 1 atm	-78.2°C	-108.8°F
Density of gas at 24°C (75°F) and 1 atm	5.734 kg/m ³	0.357 lb/ft ³
Specific gravity of gas at 24°C and 1 atm	4.823	4.823
Density of liquid at -80.0°C	1611 kg/m ³	100.6 lb/ft ³

5 Analytical Procedures (See Notes 1, 2, 3, and Figure 1)

5.1 *Oxygen, Nitrogen, Carbon Monoxide, and Carbon Dioxide* — This procedure is for the determination of oxygen, nitrogen, carbon monoxide, and carbon dioxide in hexafluoroethane using a gas chromatograph with an ultrasonic detector.

5.1.1 *Detection Limit* — 0.5 ppm (mol/mol) for each impurity.

5.1.2 *Instrument Parameters*

5.1.2.1 *Columns:*

Column 1:	Haysep D, 100/120 mesh, 4.6 m (15 ft) by 3.2 mm (1/8 in) OD ss, or equivalent.
Column 2:	Porapak QS, 100/120 mesh, 2.1 m (7 ft) by 3.2 mm (1/8 in) OD ss, or equivalent.
Column 3:	Porapak QS, 100/120 mesh, 3.6 m (2 ft) by 3.2 mm (1/8 in) OD ss, or equivalent.
Column 4:	Haysep D, 100/120 mesh, 4.6 m (15 ft) by 3.2 mm (1/8 in) OD ss, or equivalent.
Column 5:	Molecular Sieve 13×, 45/60 mesh, 2.1 m (7 ft) by 3.2 mm (1/8 in) OD ss, or equivalent.

5.1.2.2 *Carrier Flow:* 16 mL/min helium

5.1.2.3 *Sample Volume:* 1.0 and 2.0 mL

5.1.2.4 *Temperatures:*

Detector	120°C
Column 1, 2 and 5	50°C
Column 3 and 4	90°C
Valve	90°C

5.1.2.5 *Time Table* — Determine the times for valve switching and signal changes, and enter into the run table.

An example run table follows:

Valve	On	Off
1	0.01	*
2	9.20	*
3	0.01	12.00

* Valve left on until end of run.

5.1.3 *Calibration Standard* — 1–5 ppm (mol/mol) each carbon dioxide, nitrogen, oxygen and carbon monoxide, balance helium.

5.1.4 *Operating Procedure*

5.1.4.1 Inject a sample of the calibration standard into the column using a gas sampling valve. Record retention times and peak areas. The approximate retention times are: oxygen 11.1 minutes, nitrogen 11.6

minutes, carbon monoxide 14.5 minutes and carbon dioxide 15.9 minutes.

5.1.4.2 Analyze the hexafluoroethane sample to be tested in the same manner as in 5.1.4.1

5.1.4.3 Repeat 5.1.4.1.

5.1.4.4 Calculate the concentration of oxygen, nitrogen, carbon monoxide and carbon dioxide in the sample, using the formula below. The result may not exceed specification in Section 2 of this Standard.

$$\frac{\text{Sample Peak Area}}{\text{Standard Peak Area}} \times \text{Concentration of Standard} = \text{Concentration of Sample}$$

5.2 *Halogenated Hydrocarbons* — This procedure is for the determination of halogenated hydrocarbons in hexafluoroethane using a gas chromatograph with a flame ionization detector.

5.2.1 *Detection Limit* — 0.5 ppm (mol/mol).

5.2.2 *Instrument Parameters*

5.2.2.1 Column: 1% SP-1000 on Carbowax B, 60/80 mesh, 7.3 m (24 ft) by 3.2 mm (1/8 in) OD ss, or equivalent.

5.2.2.2 Carrier Flow: 40 mL/min helium

5.2.2.3 Support Gases: Set the flow rates as specified by the instrument manufacturer.

5.2.2.4 Sample Volume: 2.0 mL

5.2.2.5 Temperatures:

Detector	250°C
Initial Oven	35°C
Pre-Program Hold	7 min
Temperature Rise	10°C/min
Final Oven	150°C

5.2.3 *Calibration Standard* — 5 ppm (mol/mol) each CF₃H, C₂F₆, CF₃Cl, CF₂HCl, C₂F₅Cl balance helium.

5.2.4 *Operating Procedure*

5.2.4.1 Inject a sample of the calibration standard into the column using a gas sampling valve. Record retention times and peak areas. The order of elution is CF₃H, C₂F₆, CF₃Cl, CF₂HCl, C₂F₅Cl.

5.2.4.2 Analyze the hexafluoroethane sample to be tested in the same manner as in 5.2.4.1.

5.2.4.3 Repeat 5.2.4.1.

5.2.4.4 Calculate the concentration of each impurity in the sample using the formula below. Total the amounts of chlorofluorocarbons and hydrofluorocarbons. The

result may not exceed the specification in Section 2 of this Standard.

$$\frac{\text{Sample Peak Area}}{\text{Standard Peak Area}} \times \text{Concentration of Standard} = \text{Concentration of Sample}$$

5.3 *Water (See Note 4)* — This procedure is for the determination of trace moisture (water) in hexafluoroethane, using a continuous flowing electrolytic hygrometer.

5.3.1 *Detection Limit* — 1.0 ppm (ppmw). This is equivalent to a frostpoint of -76°C (-105°F).

5.3.2 *Sample Pressure and Flow* — Set in accordance with instrument manufacturer's instructions.

5.3.3 *Operation Check* — The instrument should be checked periodically for correct operation. A gas containing a known amount of moisture should be passed through the instrument. Agreement between the hygrometer and the standard should be within their relative accuracies.

5.3.4 *Operating Procedure*

5.3.4.1 Obtain a continuous flow sample of the hexafluoroethane source, using a clean, electropolished or passivated (see Note 5) stainless steel line which has been purged dry after exposure to ambient moisture.

5.3.4.2 After purging with a dry gas, allow the sample gas to flow through the sampling system and hygrometer until a stable reading is obtained. The reading may not exceed specification in Section 2 of this Standard.

5.4 *Notes*

NOTE 1: Introduce the calibration standard as many times as necessary to achieve the desired precision.

NOTE 2: All gases used in the analysis of the sample should not contain more than 10% of the specified value of the component of interest, unless otherwise stated.

NOTE 3: Samples of hexafluoroethane should be equilibrated at no less than 22°C (72°F) for at least 24 hours prior to analysis to ensure that the material, whose critical temperature is 20°C (68°F), is single phase.

NOTE 4: The sampling system and hygrometer must be designed to operate at the sample pressure, or the sample pressure must be reduced (by a regulator with a stainless steel diaphragm) to accommodate the pressure restrictions of the hygrometer.

NOTE 5: A passivation procedure is described in [Metals Handbook](#), Eighth Edition, Volume 2, ASM International, Metals Park, Ohio.