

SEMI PV5-1110 (Reapproved 1115) GUIDE FOR OXYGEN (O₂), BULK, USED IN PHOTOVOLTAIC APPLICATIONS

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1 Purpose

1.1 This Document provides suggested maximum impurity levels for different grades of oxygen (O₂) that are used in the photovoltaic industry.

2 Scope

2.1 This Document refers to an 'as supplied' product; not point of use. Its quality is determined in a gaseous phase, at a delivery point agreed between the supplier and user, regardless of the phase in which the material was delivered.

2.2 This Document is a Guide and complete analytical methods are not contained within. A selected list of available techniques is found in § 8, Available Techniques.

NOTICE: SEMI Standards and Safety Guidelines do not purport to address all safety issues associated with their use. It is the responsibility of the users of the Documents to establish appropriate safety and health practices, and determine the applicability of regulatory or other limitations prior to use.

3 Description

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

4 Referenced Standards and Documents

4.1 *SEMI Standards and Safety Guidelines*

SEMI C10 — Guide for Determination of Method Detection Limits

NOTICE: Unless otherwise indicated, all documents cited shall be the latest published versions.

5 Terminology

5.1 None.

6 Properties of Oxygen

Table 1 Properties of Oxygen (for information only)

	<i>Metric Units</i>	<i>US Units</i>
CAS Number	7782-44-7	7782-44-7
Molecular Formula	O ₂	O ₂
Molecular weight	31.999	31.999
Boiling point at 1 atm	-183.0°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	1.1049	1.1049
Density of liquid at boiling point	1142 kg/m ³	71.27 lb/ft ³

7 Suggested Values for Oxygen

Table 2 Suggested Values for Oxygen

<i>Grade</i> ^{#1}		99.99%	99.995%	99.999%
<i>Impurities</i>	<i>Available Techniques</i> ^{#2}	<i>Maximum Level (ppm-v)</i> ^{#3}		
Argon (Ar) ^{#4}	GC-DID, GC-HID, GC-PDHID, GC-MS, GC-PAED	20.0	10.0	3.0
Carbon Dioxide (CO ₂)	FID, GC-FID, FTIR, GC-MS, NDIR, GC-HID, GC-DID, GC-PDHID, GC-PAED	1.0	0.5	0.5
Carbon Monoxide (CO)	GC-RCP, GC-RGD, GC-MS, NDIR, GC-HID, GC-DID, GC-PDHID, GC-PAED	1.0	0.5	0.2
Nitrogen (N ₂)	GC-DID, GC-HID, GC-PDHID, GC-MS, GC-PAED	20.0	20.0	3.0
Total Hydrocarbons (as CH ₄)	FID, GC-FID, GC-MS, GC-PAED	1.0	0.5	0.5
Water (H ₂ O) (v/v)	P ₂ O ₅ , Piezoelectric, Capacitance, TDLAS, CRDS, CMH, FTIR	10.0	1.0	1.0
TOTAL SPECIFIED IMPURITIES		53.0	32.5	8.2
Particles	LPC (≥0.1 μm)	#5	#5	#5

#1 A numerical Grade is defined as the value achieved when the specified impurities are subtracted from 100%.

#2 To be used to determine if a sample of gas conforms to these criteria, the detection limit (as determined using SEMI C10) must be no more than the Maximum Level. Known analytical interferences should be considered. See § 8.

#3 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.

#4 Neon, Krypton and Xenon concentrations will typically be an order of magnitude less than the Argon concentration.

#5 Number of allowable counts and units of measure to be determined between user and supplier.

8 Available Techniques

8.1 Available techniques that may be used to determine impurities are listed within this section.

8.1.1 *CMH* — Chilled Mirror Hygrometer

8.1.2 *CRDS* — Cavity Ring Down Spectroscopy

8.1.3 *DID* — Discharge Ionization Detector

8.1.4 *FID* — Flame Ionization Detector

8.1.5 *FTIR* — Fourier Transform Infrared Spectroscopy

8.1.6 *GC* — Gas Chromatograph

8.1.7 *HID* — Helium Ionization Detector

8.1.8 *LPC* — Laser Particle Counter

8.1.9 *MS* — Mass Spectrometer

8.1.10 *NDIR* — Non-Dispersive Infrared

8.1.11 *PAED* — Plasma Atomic Emission Detector (also Plasma Emission Detector)

8.1.12 *PDHID* — Pulsed Discharge Helium Ionization Detector

8.1.13 *RCP* — Reduction Components Photometer