

OXYGEN

6601

O₂

MW: 32.00

CAS: 7782-44-7

RTECS: EL9450000

METHOD: 6601, Issue 2

EVALUATION: FULL

Issue 1: 15 May 1985

Issue 2: 15 August 1994

OSHA : 19.5% (v/v) minimum
NIOSH: 19.5 to 25% (v/v) @ 760 mm Hg
ACGIH: no standard

PROPERTIES: gas; d 1.331 g/L @ 20 °C; partial pressure
 21.23 kPa (159.22 mm Hg, 20.9% v/v) @ sea
 level

SYNONYMS: None.

SAMPLING	MEASUREMENT
<p>SAMPLER: PORTABLE DIRECT-READING OXYGEN MONITOR</p> <p>FLOW RATE: samples by diffusion; no pump needed</p> <p>VOL-MIN: 1 L -MAX: none</p> <p>SHIPMENT: routine shipment of instrumentation</p> <p>SAMPLE STABILITY: bag samples stable 4 h</p> <p>BLANKS: fresh air or compressed synthetic air from cylinders</p>	<p>TECHNIQUE: ELECTROCHEMICAL SENSOR</p> <p>ANALYTE: oxygen</p> <p>RESPONSE TIME: 5 to 25 sec for step change from 21% (v/v) O₂ to 19.5% (v/v) O₂ [1]</p> <p>CALIBRATION: fresh air or compressed gas tank calibration standards</p> <p>RANGE: 0 to 25% (v/v) O₂ in N₂ (linear response)</p> <p>SENSITIVITY: 0.1% (v/v) O₂</p> <p>PRECISION (\hat{S}_r): 0.096 [1]</p>
ACCURACY	
<p>RANGE STUDIED: 15 to 21% (v/v) O₂ in air [1]</p> <p>BIAS: none [1]</p> <p>OVERALL PRECISION ($\hat{S}_{r,T}$): 0.096 [1]</p> <p>ACCURACY: ± 19%</p>	

APPLICABILITY: The working range is 0 to 25% (v/v) O₂. For some monitors, the working range is 0 to 100%. This method may be used in work atmospheres to determine available O₂ levels and is particularly useful for determining safe entry conditions into confined work spaces. Many units are small enough to be worn on the person and may be used to obtain personal breathing zone samples.

INTERFERENCES: Levels of up to five times the TLV of many common industrial chemicals did not adversely affect the studied sensors [1]. Pressure and temperature changes do affect the sensors. Most units are equipped with temperature-compensating circuitry, but some take up to 1 h to equilibrate. Several models include pressure-compensating circuitry.

OTHER METHODS: None studied by NIOSH. This method was written as a result of evaluation of 18 commercially available oxygen monitors [2].

REAGENTS:

1. Fresh air or 20.9% O₂, 79.1% N₂ in compressed gas cylinder.*
2. 16% O₂, 84% N₂ in compressed gas cylinder for calibration.*

* See SPECIAL PRECAUTIONS.

EQUIPMENT:

1. Oxygen monitor with electrochemical sensor with the following performance specifications: linear response between 15 and 21% O₂ in nitrogen; span and zero drift ≤0.2% O₂ for 8 h; response time ≤0.5 min for a 1% change in oxygen concentration.
2. Air pump, 0.2 to 2 L/min, and plastic tubing to sample remote locations (optional).
3. Sample bags to collect samples (optional).
4. Sensor cap with inlet and outlet fittings to calibrate from compressed standard cylinders in contaminated atmospheres.
5. Air line adaptor for sampling oxygen-enriched air.

SPECIAL PRECAUTIONS: Shipments of compressed calibration gases must comply with 49 CFR 1992 regulations.

SAMPLING AND MEASUREMENT:

1. Start monitor as manufacturer recommends. Allow sufficient warm up/equilibration time if monitor has been in a different environment. If a remote sensor is used in an area different from the monitor electronics, allow extra time to reach thermal equilibrium.
NOTE: Instrument warm-up time is typically 10 min or less, but may increase to as long as 1 h if sampled atmosphere varies 5 °C or more from present ambient temperature.
2. Select one of the following sampling modes as appropriate:
 - a. **Ambient air or oxygen-deficient air:**
 - (1) Place monitor in atmosphere to be analyzed. Allow to equilibrate.
 - (2) Record % O₂. Read and record frequently. Observe any downward trends in % O₂ levels. If a concentration of 19.5% O₂ is approached, ventilate with fresh air if possible.
WARNING: EVACUATE THE AREA WHEN THE O₂ CONCENTRATION FALLS BELOW 19.5% [3].
 - b. **Oxygen-enriched air:**
 - (1) Place sensor in air line adaptor. Allow to equilibrate.
NOTE: If line is pressurized, bleed off a stream to the sensor at atmospheric pressure in order to not pressurize the sensor.
 - (2) Record % O₂.

CALIBRATION AND QUALITY CONTROL:

3. Perform on-site calibration at 20.9% O₂ several times each shift by exposing sensor to fresh air or to standard tank air. Replace sensor cell when the instrument can no longer be adjusted to read 20.9% O₂ in fresh air.
WARNING: DO NOT PRESSURIZE THE SENSOR WITH CYLINDER MIXTURES AS THIS WILL CAUSE HIGH READINGS AND COULD DO IRREPARABLE DAMAGE TO THE SENSOR CELL.
4. Perform down-scale calibration by exposing sensor to 16 to 19% O₂ in N₂ at least once per day.
5. Check for alarm function (if included) by exposing to 16 to 19% O₂ in N₂ from a cylinder or by blowing self-exhaled breath directly onto the sensor. Following manufacturer's instructions for this procedure, adjust readout meter to agree with the calibration standard.

6. Practice routine instrument maintenance.
 - a. Check sensor cell diffusion barrier for dirt and moisture. Clean with a soft cloth or tissue if needed.
 - b. Replace sensor cell every six to nine months with average use.
NOTE 1: Store cell in nitrogen when not in use to prolong life.
NOTE 2: Some models use non-disposable, user-rechargeable sensors which require recharging every two to four weeks.
 - c. Check batteries and replace when needed.
NOTE: Battery life is two to six months for replaceable battery models. Some are equipped with nickel-cadmium batteries which require periodic recharging. Most operate at least 16 hrs without recharging. Some units have low-battery indicators.

EVALUATION OF METHOD:

Oxygen monitors have been used successfully in numerous industries for pre-entry checks of areas where oxygen levels may be low and for continuous monitoring during the time workers occupy these areas [3]. They have also been used in hospitals for monitoring oxygen levels in oxygen-enriched atmospheres supplied for medical purposes. This method has undergone extensive laboratory evaluation for use in oxygen-deficient atmospheres and has been shown to be stable and reproducible [1]. The relative standard deviation, S_r , for 15 different instruments monitoring the same atmosphere (under laboratory conditions) was 0.52% for over 100 readings over an 8-h period. The relative standard deviation, S_r , for 18 different instruments monitoring the same atmosphere in field situations was 1.22% for 126 readings taken over a two-day testing period with calibration at the beginning of each day [1].

REFERENCES:

- [1] Woodfin, W. J. and M. L. Wuebkenberg. An Evaluation of Portable Direct-Reading Oxygen Deficiency Monitors (NIOSH, unpublished, 1984).
- [2] Katz, Morris, Ph.D., Ed. Methods of Air Sampling and Analysis (Second Edition), Library of Congress Cat. No. 77-6876, American Public Health Association (1977).
- [3] Criteria for a Recommended Standard...Working in Confined Spaces, U.S. Department of Health, Education, and Welfare, Publ. (NIOSH) 80-106 (1979).

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