TELEDYNE ANALYTICAL INSTRUMENTS

Teledyne's patented Micro-fuel Cell (MFC) is a unique, electrochemical transducer that provides versatile oxygen sensing capability by combining the following features.

Specificity to Oxygen

- Completely maintenance free
- Absolute zero - requires no "zero" gases
- Long life
- Long term stability, two to four weeks (and longer) calibration interval
- Unaffected by variations in sample flow rate
- Unaffected by shock, vibration or position

Theory of Operation

Oxygen in the gas space surrounding the cell diffuses through a Teflon membrane and is reduced on the surface of the cathode. A corresponding oxidation occurs at the anode internally and an electrical current is produced that is proportional to the concentration of oxygen.

Cathodic reaction: $4e^- + 2H_2O + O_2 \rightarrow 4OH^-$

Anodic reaction: $2OH^- = Pb \rightarrow PbO + H_2O + 2e^-$

Overall reaction: $2Pb + O_2 \rightarrow 2PbO$

The transducer operates thusly as a fuel cell, and its output is limited only by the rate at which oxygen enters the cell and the amount of anode material stored within. This output is insufficient for the cell to be utilized as a power source, which is the purpose of most fuel cells. However, the cell does provide sufficient output to drive meters directly or, after amplification, will provide outputs capable of performing more complicated functions.

Physical Characteristics

The MFC is a sealed, disposable oxygen transducer that measures 1.25 inches in diameter and is .75 inches thick. It has a relatively large sensing area (0.7 inches diameter) that produces a high level output signal that does not require amplification to drive analog display devices.

The large sensing area also reduces the reading errors associated with vapor condensation from sample streams that normally cause small sensing area transducers to read low or even zero.

The rear of the MFC is covered by a contact plate that consists of two concentric foils. These foils mate to spring loaded contacts in the various probe assemblies and sample manifolds in which the cells are housed.

Features

The MFC combines several important features to provide what TAI feels is the most desirable and versatile performance characteristics of any oxygen sensor currently available.

No maintenance is associated with the use of the MFC. There are no electrodes to clean or replace and no electrolytes or membranes to change, eliminating the need for specially trained operating personnel and reducing the number of maintenance man-hours to a minimum. This is probably the most significant area of cost savings associated with providing analytical instrumentation. Costs associated with maintenance can run several times the initial cost of the instruments themselves.

In the absence of oxygen, there is virtually no output from the MFC. This means no "zero" gases are required in an analyzer using these transducers. The MFC is specific to oxygen and gives no output in the presence of other inorganic and organic gases. The only exception is for strong inorganic oxidizing gases such as chlorine, fluorine, bromine, etc.

The MFC has a stable output. It is not uncommon to run a cell at a constant oxygen concentration for weeks and observe that the reading has not varied more that ±1% of full scale. TAI recommends a 2 to 4 week calibration check. However, some customers run calibration checks as infrequently as 2 to 4 times a year with satisfactory results.

The MFC is designed to give long-term, reliable performance and respond rapidly to changes in oxygen concentration. The useful life of the cell depends on the length of time it is exposed to oxygen and the magnitude of the oxygen concentration.

In air (20.9% oxygen), the cells provide 3 to 18 months of life depending on cell class. If left in its original gas barrier bag, life expectancy will deteriorate only 1/20 of its "in air life" per year of storage. A shelf life from 1 to 3 years and more is common. The 90% response time of the MFC is from 5 - 60 seconds and is also dependent on cell class.

The MFC was designed to be insensitive to shock, vibration and position. The cell can be dropped with no adverse effects or mounted in nearly any position without changing sensitivity. Since sampling of oxygen is diffusion controlled (through the membrane), the rate at which the sample gas flows over the cell is not critical. Flow rates in the 0.1 to 10 liters/minute range cause no change in the reading (providing no significant back pressure is produced.)

Micro-fuel Cells

Class	Application	Comments
A-1	Ultra-fast response (90% in less than 4 seconds) in the percent oxygen region.	Use only when B-1 response time is insufficient.
A-2C	Used for trace O2 measurements in CO2 containing backgrounds (0.1-100% CO2). CO2 must be present.	Use where acid gases are present (CO2, HCl, HCN, etc). CO2 must be present.
A-2CXL	Specially qualified A2C sensor to operate in XL model analyzers. Low range limit is 0-1 ppm.	Use where acid gases are present (CO2, HCl, HCN, etc). CO2 must be present.
A-5	Intermittent or continuous monitoring of percent O2 in gas mixtures containing 0-100% CO2. 90% response is time is 45 seconds.	Has more tolerance to exposure to air than A-3. No restrictions on CO2 concentration.
B-1	General purpose percent oxygen analysis where fast response is desired (90% in less than 7 seconds).	Use B-3 or C-3 where longer life is required and response time is relatively unimportant. May be used to spot check flue gas.
B-2C	General purpose trace O2 analysis for use in inert gas and hydrocarbon streams. Low range limit is 0-10 ppm.	May be used in CO2 free gas streams containing highly mobile gases such as H2, He and ethylene.
B-2CXL	Specially qualified B-2C sensor to operate in XL model analyzers. Low range limit is 0-1 ppm.	May be used in CO2 free gas streams containing highly mobile gases such as H2, He and ethylene.
B-3	Percent O2 analysis, best compromise between long life and fast response.	May be used to spot check flue gas.
B-5	Special application cell (non-standard) where long life and moderately fast response are required; B-5 has a factor of 3x the life of a B-3.	Requires 3x the amplifier gain of the B-3. Expected life is 36 months in air.
B-5F	Special application cell (non-standard) where long life and moderately fast response, in the presence of CO2, are required.	Uses Type F (acid electrolyte). Requires higher amplifier gain than normal. 90% response in 13 seconds. Expected life in air is 6 months.
B-7	Special application cell (non-standard) where fast response is required; the B-7 has a factor of 3x the life of a B-1 cell.	Requires 3x the amplifier gain of the B-1. Expected life in air is 24 months.
B-7F	Special application cell (non-standard) where moderate life and fast response, in the presence of CO2, are required.	Requires higher amplifier gain than normal. 90% response time is 7 seconds. Expected life in air is 3 months.
C-3	Percent O2 measurements where maximum cell life is desired (high O2 applications).	90% response time is 30 seconds. Expected life in air is 18 months.
C-5	Special application cell (non-standard) where long life is required; the C-5 has a factor of 3x the life of a C-3 cell.	Requires 3x the amplifier gain of the C-3. Expected life in air is 54 months.
C-5F	Special application cell (non-standard) where long life, in the presence of CO2, is required.	Requires higher amplifier gain than normal. 90% response time is 30 seconds. Expected life in air is 9 months.
C-6	Motion insensitive percent O2 measurements for use in hand held portable monitors.	Best cell for OEM safety applications.
InstaTrace	Special patented construction provides rapid recovery during initial cell installation; Low range limit is 0-10 ppm.	Used for trace O2 analysis in inert gas and hydrocarbon streams.
InstaTrace CO2	Special patented construction provides rapid recovery during initial cell installation by reducing the recovery period from several hours to just minutes. Used for trace O2 measurements in CO2 containing backgrounds (0-100% CO2) in the 3000T analyzer series.	Use where acid gases are present (CO2, HCl, HCN, etc). CO2 must be present. The INSTA TRACE Micro-fuel Cell oxygen sensor is capable of measuring below 1 ppm of oxygen within 15 minutes of installation.
InstaTrace XL	Specially qualified sensor to operate in XL model analyzers with a low range limit of 0-1 ppm.	Used for trace O2 analysis in inert gas and hydrocarbon streams.

This is just a sample of the full line of sensors available from Teledyne. For a complete list of industrial, OEM, medical, and diving sensors, please visit our website.

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Warranty

Instrument is warranted for 1 year against defects in material or workmanship

NOTE: Specifications and features will vary with application. The above are established and validated during design, but are not to be construed as test criteria for every product. All specifications and features are subject to change without notice.