TECHNICAL INFORMATION ON

TELEDYNE MICRO-FUEL CELLS

November 1994

15 Station Road -
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8D20 7DT Tel - 0535 634900 Fax
-0535 635582

Company Regis tration• 23322105

Information on Oxygen Sensors

All sensors measure partial Pressure e..g

1Bar = 0.21

2Bar =-0.42 and are temperature dependent

T-1 requires external temperature compensation.:

30 Sec response time to 90% of 0_2 change.

The T-1 complete with its temperature compensation circuit will feed directly a lOOMicroAmp analogue meter with an input impedance of lKohm.(see diagram)

The estimated life of aT-l inair is 18 months

The T-1 has a PCB base but can be supplied with a connector and temperature compensation components already fitted.

R-17 & R-22:have interal compensaflon

6 Sec response to 90% of 0_2 change.

They have a nominal output of 10.5 mv (+/- 30%) in air into 10Kohm impedance.

48 months. expected life in air.

The life is dependent on the amount of Oxygen the sensor is exposed to.

The R-17 terminates in a locking Jack socket and we can supply matching integral lockable plugs

The sensors are not seriously affected by Helium:

80% Volume Dry being equivalent to 1% Oxygen.

Sensor Life expectancy

This can be calculated $\frac{\text{Oxidisable material in grams} \times K \times 70\%}{\text{Sensor Output in Amps}}$

K is a proportionality constant (0.00359)

The 70% is the assumption of anode efficieny

Effects of Humidity

Humidity dilutes the gas reducing the partal pressure of 0_2.

Assuming STP (25C & 760mm) and an RH --100%

From standard tables the Vapour pressure is 23.7756rnmHg

% H_20= 23.756 x 100/760 3.13%

if the original mixture contained 21% Oxygen

The actual reading would be 20.9 - (20.9-3.13)/100 = 20.9%

36% 02 reading would be 34.8%

WARRANTY Teledyne warrants that the goods are free from defects of matetial construction for a period of 1 year from the date of shipment. There is no warranty on sensor life. Sensor life is stated in months in air depending on the sensor class this can range from 18 to 48. Air means 21 % Oxygen at 1 Bar. if used in higher levels the sensor life will be reduced.

Shelf Life: Under normal storage with no damage to the packing we can expect 1-3 years storage with no ill effects to the products performance.

Please note the warranty as dates are strictly adhered to.

THE GALVANIC OXYGEN SENSOR

The basic constituents of a sensor consists of a lead anode a gold plated cathode with a solution of Potassium Hydroxide as an electrolyte. The cathode is a convex metal disk plated with a noble metal e.g. gold, silver, platinum etc. with numerous perforations. It is designed to facilitate the continuous wetting of the upper surface and contains a small amount of electrolyte between the membrane and the cathode. This is to assure minimum internal resistance duinng the oxygen sensing reaction It is essential that this portion of the electrolyte does not dry out or the membrane be allowed to contact the cathode directly. When Oxygen is diffused into the sensor through the membrane the lead is oxidised into lead oxide and the reaction produces a snall current between anode and cathode. The lead anode is specially designed to maximise the amount of metal available for the reaction For this reason it is not solid but small particles bonded together. This increases the surface area in contact with the electrolyte and encourages even oxidisation throughout the complete electrode. The rear of the sensor has another flexible membrane which is designed to accommodate internal volume changes that occur throughout the life of the sensor without this membrane the upper membrane would move to accommodate the internal volume changes and a variation in electrical output unrelated to oxygen concentration would be the result.

The sensing membrane is made of Teflon whose thickness is very accurately controlled. The entire space between the two membranes is filled with an solution of potassium hydroxide . The main sensor body is manufactured from high density polyethylene.

Galvanic oxygen sensors require no external battery to work. They consume Oxygen and produce a small electrical current initially niel cells were designed to produce electricity in space using Oxygen as a fuel and were used by NASA in the space program to power manned space vehicles. They were subsequently miniturised into the present form providing normally 1 to 200 microwatts of power and became known as micro fuel cells. The earliest micro fuel cell sensors produced a large current output of 1 milliarnp at 100% oxygen and can drive an analogue meter direct.

August 1995

Product Identification
Product Name: Micro-Fuel Cells R-17
Manufacturer: Teledyne Brown Engineering
Address: 16830 chestnut Street,
City of Indust:ry, CA 91749
Date Prepared or Last Revised: 08/08/91

Physical and Chemical Data
Chemical and Common Names : Potassium Hydroxide (KOEr), 15% (Wv)
Granular Lead (Pb), pure
CAS Number : KOH 1310-58-3
Pb 7439-92-1

	KOR	Pb
Melting Point/Range:	10 to 0 C	328 C
Boiling Point/Range:	100 to 115 C	1744 C
SpecificGravity:	1.09CTh.20C	11.34
pH:	14	N/A
Solubility in Water:	Completely soluble	Insoluble
Percent Volatile by Volume:	None	N/A
Appearance and Odour	Colourless, Grey metal, Odourless Solution	

Physical Hazards
Potential for fire and explosion

The electrolyte in the Nflcro-Fuel Cells is not flammable.
There are no fire or explosion hazards associated with Teledyne R17 sensors.

Potential for reactivity: The sensors are stable under normal conditions of use. Avoid contact **between** the sensor electrolyte and strong acids.

Health Hazard Data
Primary route of entry: Ingestion, eye/skin contact Exposure limits:OSHA PEL: .05 mwtu.m (Pb)
ACGIH TLV : 2 mWcu.m. (KOFI)
Effects of over-exposure
Ingestion : The electrolyte could be h~ or fatal if swallowed. Eye : The electrolyte is corrosive; eye contact could result in permanent loss of vision.
Dental : The electrolyte is corrosive; skin contact could result in a chemical bur
Inhalation: Liquid inhalation is urilikely
Signs/symptoms of exposure:
Contact with skin or eyes will cause a burning sensation and/or feel soapy or slippery to touch.
Medical conditions
aggravated by exposure : None
Carcinogenity: NTP Annual Report on Carcinogens

Not Listed LARC Monographs: Not

Listed, OSHA:
Other health hazards : Lead is listed as a chemical known to the State of California to cause birth defects or other reproductive h~

Emergency and First Aid Procedures
Eye Contact: Flush eyes with water *for* at least 15 minutes and get irmediate medical attennon.
Skin Contact: Wash affected area with plenty of water and remove contaminated clothing. If binning persists, seek medical attention.
Ingestion: Give plenty of cold water. Do not induce vomiting. Seek medical attention.
Inlialation: Liquid inhalation is unlikely.

Handling Information

The oxygen sensors are sealed, and under normal circumstances, the contents of the sensors do not present a health hazard.
The following information is given as a guide in the event that a cell leaks.

Protective clothing: Rubber gloves, chemical splash goggles

Clean-up procedures: Wipe down the area several times with a wet paper towel. Use a fresh towel each time

Protective measures

During sensor replacement: Before opening the bag containing the sensor, check the sensor for **leakage. If** the sensor 1C~S, do not open the bag. If there is liquid around the sensor e.g. whilst in the instrument case, put on gloves and eye protection before removing the sensor.

Disposal

Should be in accordance **with all** applicable state, local and federal regulaflons.

NOTE: The above information is derived from the NISDS provided. The information is believed to be correct but does not purport to be all inclusive and shall be used only as a guide. Teledyne Brown Engineering shall be held liable for any damage resulting from handling or from contact with the above

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Emergency Phone Number : 0101 818 961 9221

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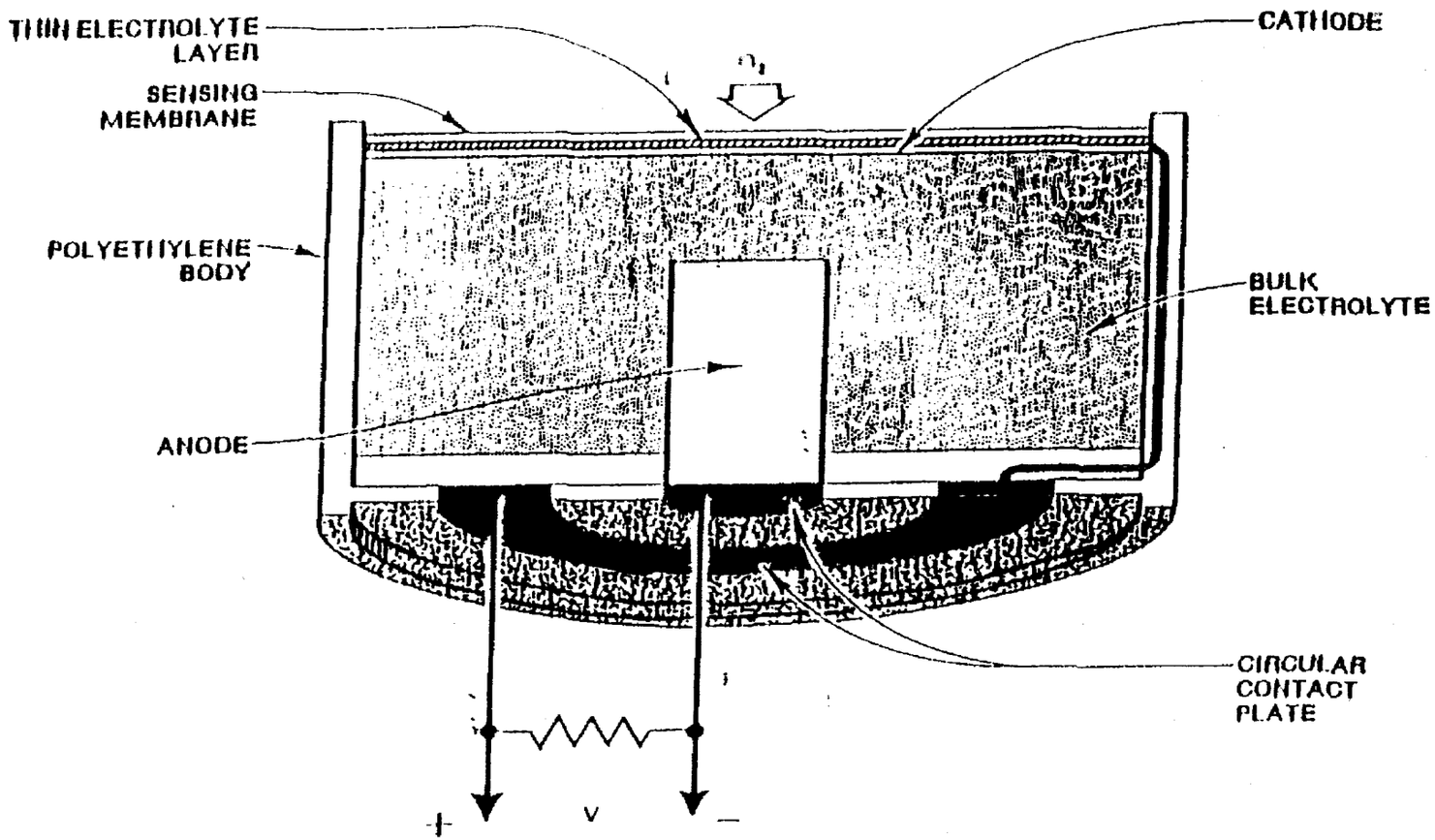
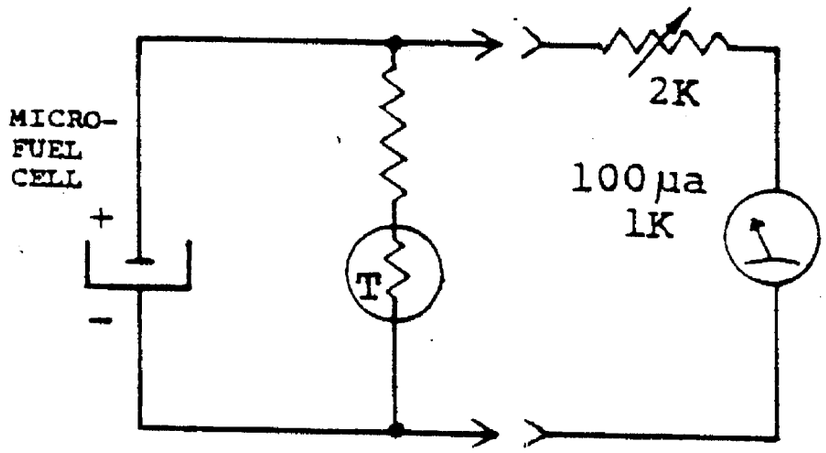

THIN ELECTROLYTE LAYER
SENSING MEMBRANE
POLYETHYLENE BODY
ANODE
CATHODE
BULK ELECTROLYTE
CIRCULAR CONTACT PLATE
V



BASIC CIRCUIT FOR USING T1 MICRO FUEL CELL

fig.1

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Keighley · West Yorkshire · BD20 7DT
Tel · 01535 634900 Fax · 01535 625582

Company Registration · 2332205

SENSOR TECHNOLOGIES
by TELEDYNE BROWN ENGINEERING

16830 Chestnut Street, P.O. Box 1580
City of Industry, California 91749-1580. USA
Phone: (818) 961-9221
Fax: (818) 961-2538

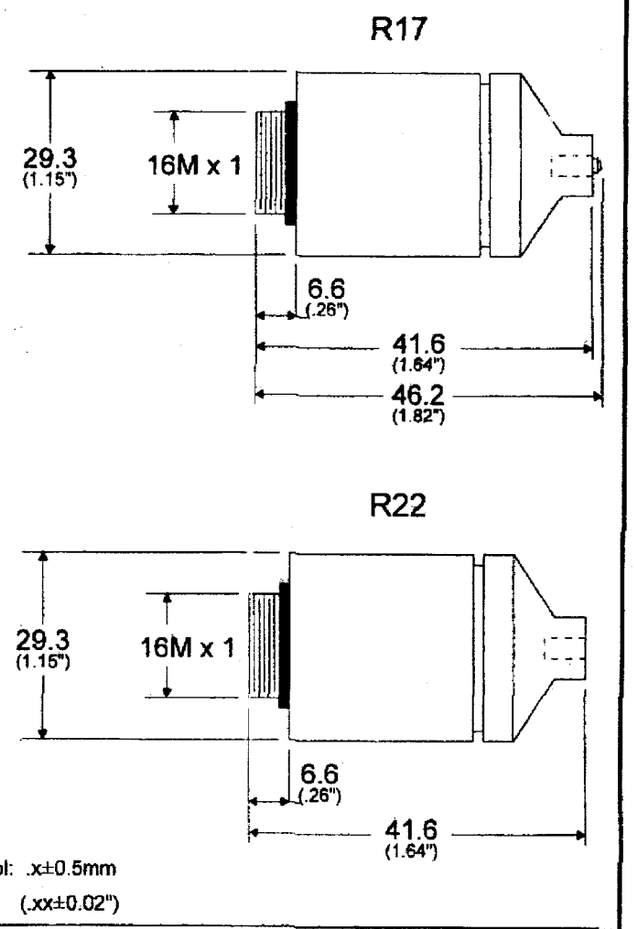
Medical Oxygen Sensors

Sensor Specifications*	
Measurement Range:	0 - 100% oxygen.
Output Voltage:	7 - 13mV in air, 25°C, sea level (standard).
Response Time:	1) Less than 6 seconds to 90% of final value.
Accuracy:	± 1% of full scale at constant temperature and pressure.
Electrical Interface:	R17: 3.5mm (.140") Switchcraft mating miniature phone plug, P/N 740 (screw terminal) or 750 (clamp-lug terminal). R22: 3 pin Molex mating plug P/N 2201-2097.
Operating & Storage Temperature:	0 - 50°C (32 - 122°F).
Operating Humidity:	0 - 95% RH.
Recommended Load:	10K Ohms.
Zero Offset Voltage:	Less than 50μV in 100% N_2 at 25°C.
Cross Interference:	Less than 1.0% O_2 response to: 6.0% Halothane. 6.0% Isoflurane. 6.0% Enflurane. 7.0% Sevoflurane. 20.0% Desflurane. 8.0% CO_2. 80.0% N_2O.
Temperature Compensation Error:	± 5% of reading over the operating temperature range (worst case tracking error of ± 10% of reading within the first hour after a maximum temperature step).
Pressure Dependence:	Directly proportional (ie. a 10% increase in pressure will yield a 10% increase in output).
Expected Lifetime:	36 months in air, 25°C, 50% RH, ambient pressure.
Weight:	32 gm (1.2 oz).
Part Number:	**C43690-R17, C44611-R22.**

September 1994

*Specifications subject to change without any prior notice

Sensor Outline Drawing



Dimensions in millimeters (inches)