INSTRUCTIONS FOR DELRIN BODY GALVANIC OXYGEN PROBE

GENERAL INFORMATION

This dissolved oxygen electrode is a galvanic type. It is designed to be interchangeable with oxygen amplifiers and other manufacturer's amplifiers with the same design specifications.

The external portion of the electrode is constructed of delrin The internal portion of the electrode is constructed of 316 L stainless steel enclosing an removable tubular lead anode and a platinum cathode. A thin teflon/silicone membrane, provides for efficient sealing of the cathode/anode and electrolyte within the cylinder. The membrane is permeable to oxygen but impermeable to water and electrolyte.

The mm galvinic DO electrode is normally shipped with 30 ml electrolyte, plastic filling syringe, membrane replacement cartridge (1), spare o-ring, and cartridge replacement tool.

PREPARATION

The electrode is shipped filled with electrolyte and with the teflon membrane in place. Upon receiving the electrode, inspect for damage. Remove protective vinyl cap.

ZERO POINT OF AMPLIFIER

The electrical zero point of the amplifier must be first set. Follow the amplifier manufacturer's operating instructions. Set the range selector on the amplifier to zero. Adjust zero indicator to read zero.

POLARIZATION

With the protective shorting cap in place, polarization voltage is applied to the anode and the cathode. Initial current is very strong, but falls off exponentially and settles down to a steady state after a few hours.

NOTE: It is advisable to keep the shorting cap in place or keep the electrode connected to the amplifier when not in use, since the polarization process takes one to two hours before current equilibration. The small current which remains and flows through the electrode will not shorten the life of the electrode. If, for any reason, the electrode must be disconnected, the amplifier switched off, or the shorting plug is not used, the electrode must be repolarized before it can be used.

TEMPERATURE COMPENSATION

Temperature compensation is not required when calibration is made at the same temperature as the controlled fermentation temperature. The fermentation process must be temperature controlled, with no temperature variation.

ELECTRODE CHECK (optional)

1. Place electrode in air-saturated DI water. Calibrate the meter to read 100% saturation by referring to the amplifier manufacturer's operating instructions.

2. Remove the electrode from the air saturated DI water.

3. Pass nitrogen gas over the electrode membrane. The electrode should react immediately and show a rapid decrease in the reading. After 45 seconds, the reading should be under 10% saturation. If not, follow the procedure for Membrane Replacement.

CALIBRATION

The zero current of the O2 electrode (electrode current at 0mm Hg O2) is usually negligibly small and almost identical with the amplifier zero point. Nonetheless, the electrode zero point should be periodically checked as some electrode faults result in an excessive zero current. Moreover, checking the zero point is necessary before the measurement of low oxygen concentration.

Zero point calibration may be effected in both pure nitrogen and in water saturated with nitrogen. A further alternative is the use of a freshly prepared 2% bisulfite solution.

The saturation of water with nitrogen takes several minutes. Calibration with pure nitrogen gas is faster and more reliable. The zero point can be read after about 5 minutes. For zero current correction on the instrument refer to the instructions on the amplifier.

Set the range selector on the amplifier to zero. Adjust the zero indicator to read zero according to the amplifier manufacturer's operating instructions. The zero current of the dissolved oxygen electrode (electrode current in pure N2) is usually negligibly small and almost identical with the amplifier zero point.

Zero point adjustment must precede slope calibration. In contradiction to zero point calibration, the aqueous phase is preferred for slope adjustment. The following problems arise in calibration done in air.

1. Membrane permeably slightly differs in air and in water.
2. Relative air humidity rarely 100%.
3. Temperature badly defined.

Calibration is usually effected at oxygen saturation since it is the simplest. In calibrating the reading is adjusted to 100% saturation. As it is dependent on pressure, the 100% adjustment should be effected under operating pressure.

Saturate the aqueous phase in the vessel by purging air at the vessel's maximum flow rate for approximately 20 minutes to create 100% air saturation. Perform the saturation of the solution under operating pressure. Allow the output signal to stabilize.

Adjust the display module to read 100% saturation according to the amplifier manufacturer's instructions.

MAINTENANCE

After the electrode has been used for a period of time, the residual current may rise. To reduce the residual current, the following cleaning method is recommended.
(see Figure)

1. Carefully unscrew cap from the body.

2. Rinse the inside of the membrane cartridge with DI water.

3. Soak the lead anode in 0.1N HCl (8.3 ml concentrated HCl in 1000 ml DI water) for 15 to 20 minutes. Rinse the lead anode with DI water, blot dry with tissue paper. Screw the lead anode back onto the body.

4. Dip the platinum cathode in aqua regia (a mixture of 3 parts HCl and 1 part HNO3) five times, 30 seconds each. After each dip, clean the platinum surface with tissue paper.

4. Rinse the soaked portions thoroughly with DI water. Blot dry with tissue paper.

5. Fill cap with electrolyte to a level just above the membrane cartridge using the syringe provided. Hold the electrode in an upright position and gently screw cap back onto the body.

6. Please inspect the membrane for tears or leakage. The membrane should be uniformly stretched across the inner body. Replace the membrane if any damage has occurred.

7. Polarize the electrode as described in the POLARIZATION section.

MEMBRANE REPLACEMENT

The membrane should be examined routinely after each fermentation cycle and replaced if any deterioration is evident.

1. Carefully unscrew cap from the body.

2. Using the membrane tool provided, pop membrane cartridge from cap.

3. After membrane cartridge is removed from cap , inspect all of the o-rings . If the o-rings appear to be damaged, please replace them with the spare o-rings provided.

4. Inspect the platinum cathode. Please wipe gently with tissue paper and see if there are any cracks or damage to it.

6. Take a new membrane out of the plastic package and insert it into cap. Push it down inside until firmly seated inside the outer cap using the membrane tool provided.

7. Fill cap with electrolyte to a level just above the membrane cartridge using the syringe provided.

8. Hold the electrode in an upright position and gently screw cap back onto the body. Please inspect the membrane for tears or leakage. The membrane should be uniformly stretched across the inner body.

9. Proceed to polarize, sterilize, and calibrate the electrode before use.

THEORY OF OPERATION

The galvanic dissolved oxygen electrode consists of polarized platinum and lead electrodes, with the electrolyte separated from the sample by teflon/silicone gas permeable membrane. Oxygen diffuses across the electrode membrane and is reduced to hydroxyl ions at the platinum cathode according to the reaction:

$$(1)\ O_2 + 2H_2O + 4e^- = 4OH^-$$

The electrons necessary for this process are produced by a reaction at the lead anode. Because the electrolyte contains hydroxide ions, this reaction occurs as:

$$(2)\ 2Pb + 4OH^- = 2Pb(OH)_2 + 4\ e^-$$

At any given temperature, the current flow between cathode and anode is directly proportional to the level of oxygen.

TROUBLESHOOTING

Problem The probe when in air-saturated water generates no potential (zero output).

Solution Check that all cable connections are correct. Check that the probe is filled with electrolyte.

Problem The output signal is reversed.

Solution Reverse the signal wires connected to the display module or recorder.

Problem The calibration potentiometer is on maximum but the signal does not reach 100%. NOTE: The output signal may not reach 100% if the ambient air temperature is less than 15 degrees.

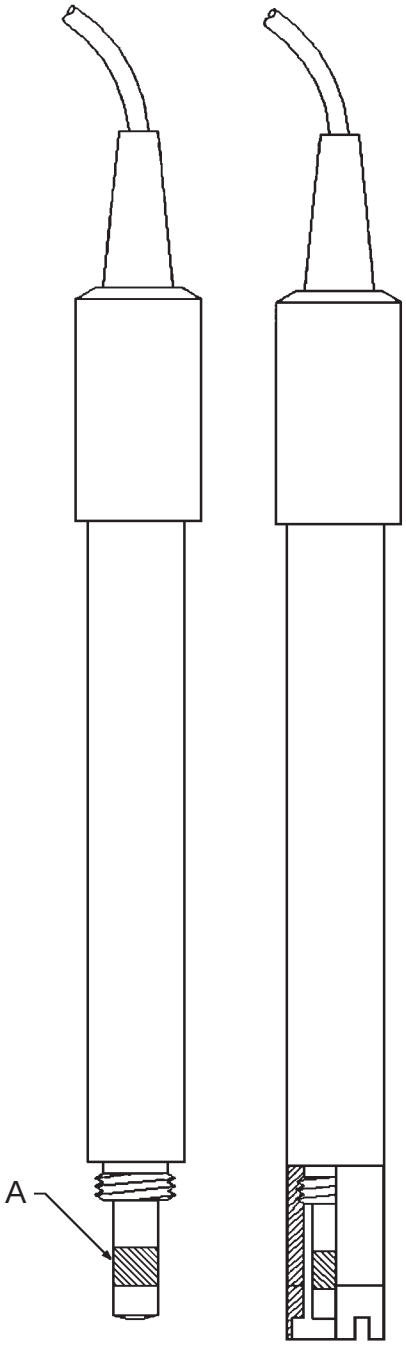
Solution Change the membrane. Change the electrolyte.

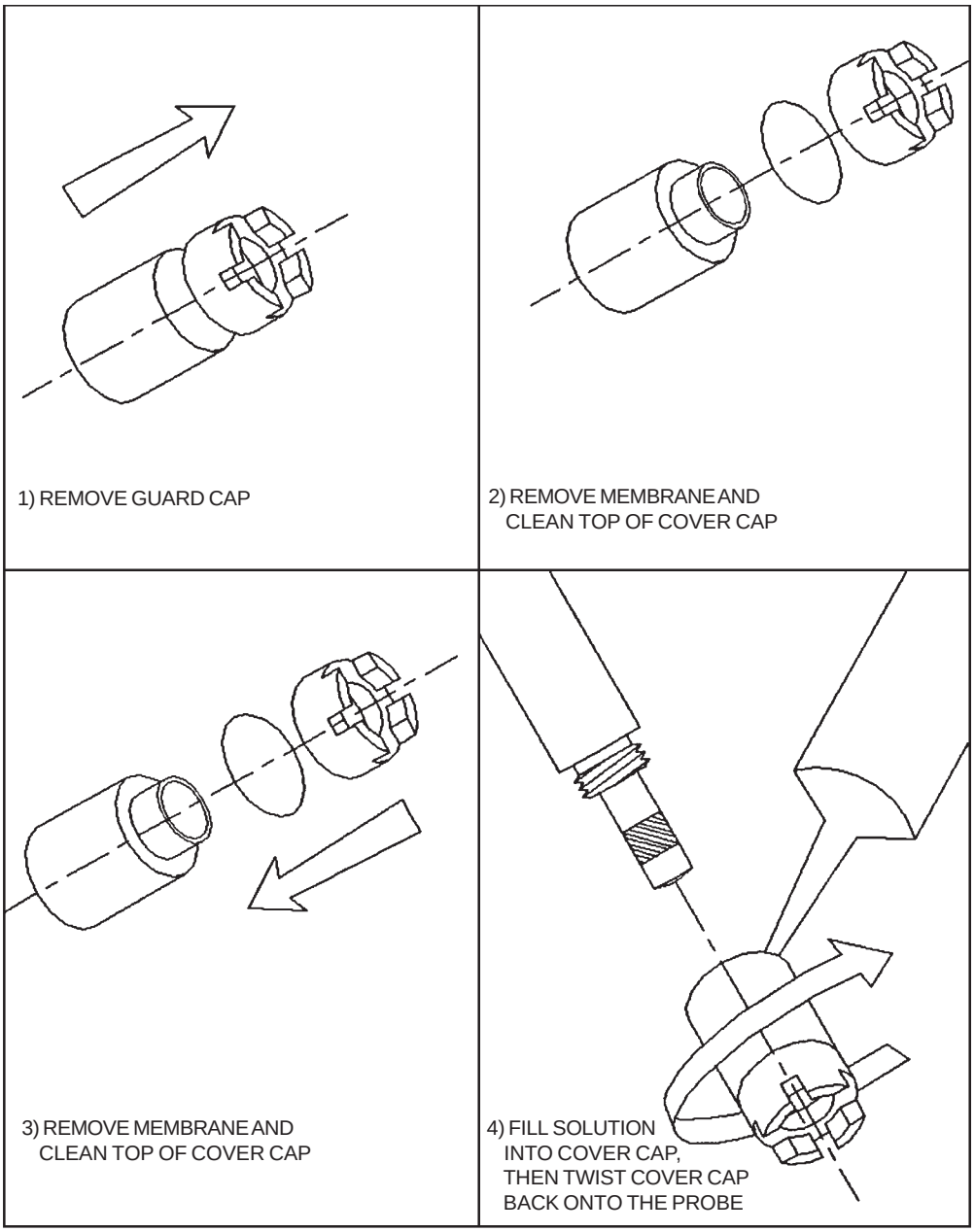
Problem The output signal is unstable and shows random drift.

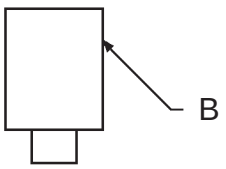
Solution Check the grounding of the fermentor and of the instrumentation.

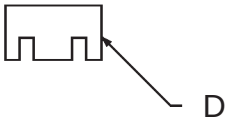
SPECIFICATIONS

Electrode body	: delrin or stainless steel
Membrane	: teflon
Cathode	: platinum
Anode	: tubular Lead
Output in air-saturated DI water	: 35 to 60 mV at 25°C (with 7.5 K resistor)
Residual Signal	: less than 1 mV.
Response time	: 90% response in less than 30 seconds
Electrolyte	: Sodium Hydroxide Solution
Stability/drift	: In water under constant pressure at constant temperature and amounts less than 2% per week









A LEAD (ANODE)
B COVER CAP
C MEMBRANE
D GUARD CAP

GALVANIC

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