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APPLICATION NOTE 32 **Revised May 1997**

Dissolved Oxygen Sensors Using the YSI 5739 Oxygen Probe

Sea-Bird's SBE 13 and 23 dissolved oxygen sensors can be configured with either a Beckman or a Yellow Springs Instruments (YSI) oxygen element. This application note applies only to YSI types.

The YSI 5739 probe has been mounted using a pressure equalization scheme that allows use to depths of 2000 meters (6500 ft). Before the sensor is tested and shipped, the probe is filled with electrolyte. Then, a high sensitivity membrane is installed, and it is calibrated.

A kit (SBE Part Number 24110) containing 30 high-sensitivity membranes and replacement KCl electrolyte solution is shipped with the oxygen sensor. Additional supplies of these items are available from Sea-Bird or Yellow Springs Instruments. Routine maintenance on this sensor involves changing the membranes and electrolyte and keeping the sensor clean using a non-ionic detergent. During periods of extended storage, YSI advises that the oxygen membrane be kept in a moist environment. For units with a pump, a small amount of water trapped in the plumbing system should suffice. On units that do not have a plenum installed (for use with a pump), a white plastic screw-on cap is provided for sensor storage. Remove the screw-on sensor guard, put a small amount of water (several drops) in the cap, and screw the cap on to the sensor. Attached to this application note is a copy of the instructions that YSI sends with the oxygen probes.

Application Note 13-1 contains information on the calibration of the instrument and the equation used by Sea-Bird software to calculate dissolved oxygen. The correct values of tcor, pcor, tau, and wt for the YSI sensor are:

tcor	=	-0.033
pcor	=	1.50e-4
tau	=	2.0
wt	=	0.85

Obtaining high quality oxygen measurements is only possible when careful attention is paid to the calibration and operation of the oxygen sensor. Whenever possible, independent measurements of oxygen should be obtained. When the oxygen sensor is mounted on a profiling instrument without a pump, a sufficient fall rate (0.75 to 1 meter/second) must be maintained to flush water past the sensor to avoid oxygen depletion at the membrane surface. In applications where the oxygen sensor is pumped, it is possible to obtain a measurement while the sensor is stationary.

To change the electrolyte and membrane the following steps should be followed. The Sea-Bird assembly drawing for the YSI sensor (drawing number 40356) and Figure 4 in the YSI instructions are referenced in these instructions.

1. Remove the plenum from pumped oxygen sensors or the sensor guard from units that are not pumped.

2. There are two styles of housings used to hold YSI sensor elements. To determine which style of housing you have, locate the black, pressure-compensation diaphragm, shown on drawing 40356, on the side of the white plastic housing. Old style housings have a white disk, shown as the DO access cap on drawing number 40356, above the pressure-compensation diaphragm. New style housings do not have the DO access cap, and are smooth above the black diaphragm. To facilitate changing the membrane, remove the DO end cap from the housing using the following specific instructions for your housing type.

OLD STYLE HOUSINGS: Using a 3/32 hex driver, remove the four or six retaining screws that hold the DO end cap to the DO housing (drawing 40356). Then gently lift the end cap off the sensor assembly.

NEW STYLE HOUSINGS: There are 6 phillips head screws in the white plastic housing. Remove the 3 screws in the end cap closest to the sensor membrane, above the pressure compensation port. DO NOT remove the other 3 screws, which are below the pressure compensation diaphragm and closest to the aluminum pressure housing. Gently lift the end cap off the sensor assembly. This will expose the electrolyte diaphragm and facilitate the replacement of the oxygen membrane.

3. If you have an OLD STYLE HOUSING, remove the DO access cap by gently pulling with a twisting motion. The removal of this cap exposes the electrolyte diaphragm on the YSI probe.

4. Gently remove the membrane O-ring and the membrane itself, taking care not to touch the gold cathode.

5. Empty the electrolyte chamber by turning the sensor over and gently pumping the electrolyte diaphragm with the eraser end of a pencil or Q-tip. (YSI Figure 4A). NOTE: There are 2 diaphragms on the housing. The lower, pressure-compensation diaphragm, visible on the side of the housing before disassembly, should NOT be pumped. The electrolyte diaphragm is the diaphragm closer to the sensor membrane, which was exposed in steps 2 and 3.

6. Assemble the following items needed for the next few steps: Q-tips, high-sensitivity membrane booklet, electrolyte refill bottle, and new membrane O-ring.

7. Hold the sensor assembly vertical and place a few drops of electrolyte solution in the top of the sensor. With a Q-tip or pencil eraser gently pump the electrolyte diaphragm to draw the electrolyte into the reservoir (YSI Figure 4A). Repeat this step until there are no more bubbles coming out of the reservoir. When no more bubbles appear, add one or two more drops of electrolyte to form a nice meniscus on the top of the sensor.

8. Referring to YSI Figure 4B, secure a high-sensitivity membrane between your thumb and the probe body. Try not to dislodge the meniscus of electrolyte solution. If the meniscus drips away, add a few more drops of solution. Take care to handle the membrane at the ends only.

9. With the thumb and forefinger of your free hand, grasp the free end of the membrane (YSI Figure 4C) and with a continuous motion *stretch* the membrane **up, over,** and **down** the other side of the sensor head (YSI Figure 4D). Stretching forms the membrane to the contour of the probe.

10. Secure the end of the membrane under the forefinger of your left hand while holding the probe. This may take some practice, as the membrane must remain taut. (YSI Figure 4E)

11. Gently place the O-ring on top of the membrane and place a drop of electrolyte solution in the center of the O-ring. This will help lubricate the O-ring as it is placed over the membrane. Roll the O-ring over the end of the probe, being careful not to touch the membrane surface (YSI Figure 4F). There should be no wrinkles in the membrane and no air bubbles trapped under the membrane. Some wrinkles may be removed by lightly tugging on the edges of the membrane beyond the O-ring. It may take some practice to acquire the coordination necessary to properly install a membrane. If the membrane gets wrinkled or punctured, take off the O-ring, discard the membrane, add a few drops of electrolyte to reform the meniscus, and try again.

12. Trim off the excess membrane with sharp scissors. **Do not use an Exacto Knife!** There is too great a risk of cutting the O-ring or slipping and puncturing the membrane. Check that the stainless steel thermistor tube is not covered by excess membrane (YSI Figure 4G).

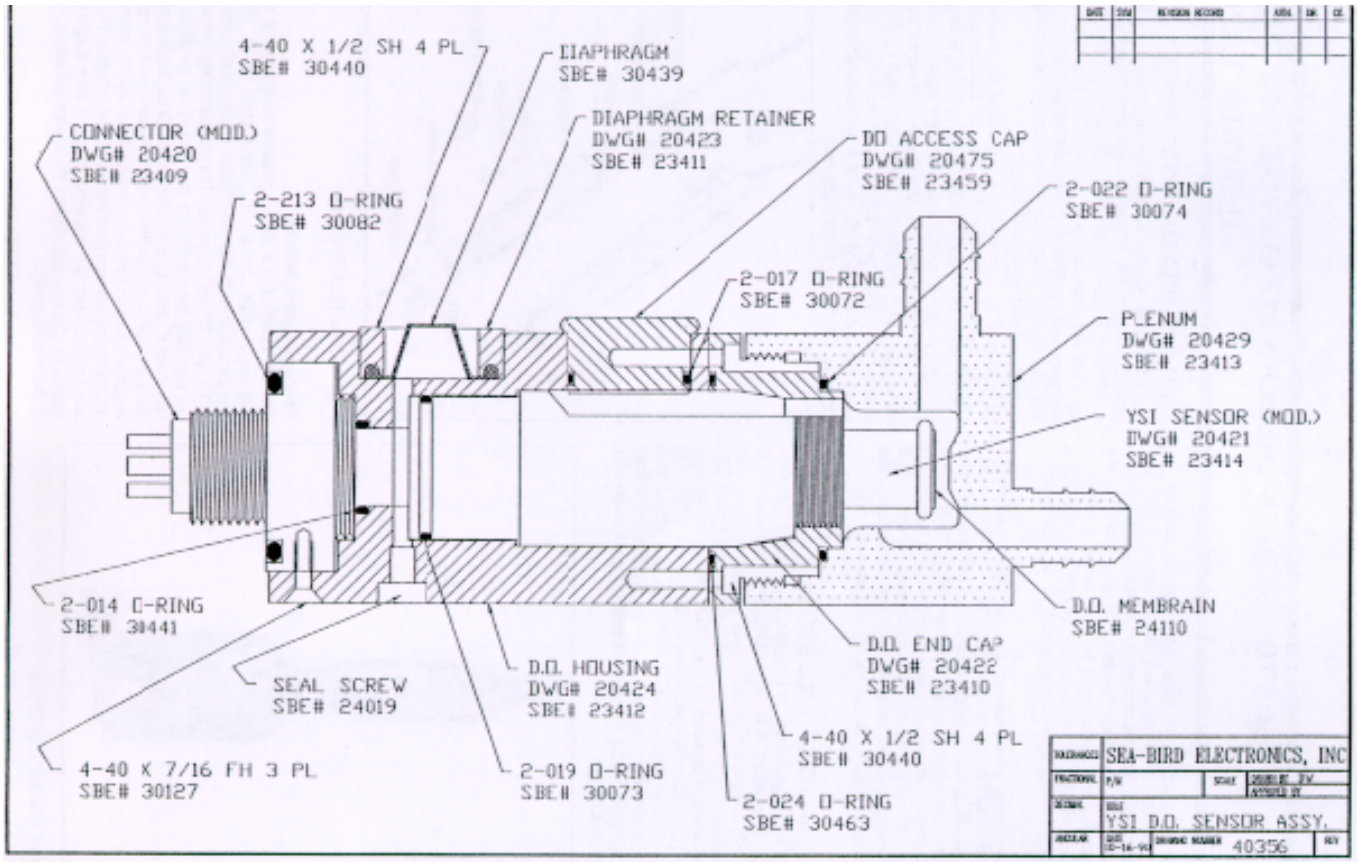
13. For old style housings, reinstall the DO access cap with a slight twisting motion to seat the O-ring. Align the 4-40 hole in the access cap with the matching hole in the body.

14. Carefully place the DO end cap over the YSI sensor probe and line up the mounting holes with the matching holes in the DO housing. You may have to "fit" the end cap by turning it 90 degrees, pressing it into place, then turning it back to line up with the screw holes. Be sure that you don't turn the YSI sensor itself; on old style housings the electrolyte diaphragm on the YSI probe must remain aligned with the access hole in the DO housing.

15. OLD STYLE HOUSINGS: Install the four 4-40 x 1/2" screws that hold the DO end cap to the DO housing. Tighten these screws gently in an alternating pattern to avoid stripping the threads in the plastic housing. The DO end cap may not sit flush against the DO housing. This is normal, as there is no O-ring groove in the DO housing. Do not distort the plastic parts by over-tightening the screws in an attempt to make parts fit flush.

    NEW STYLE HOUSINGS: Press the end cap down firmly on the housing until it seats against the housing. Replace the 3 phillips head screws, being careful not to over-tighten them into the plastic housing.

16. Rinse the reassembled unit with distilled or deionized water to wash away electrolyte. Carefully reinstall the plenum.


4-40 X 1/2 SH 4 PL
SBE# 30440
DIAPHRAGM
SBE# 30439
DIAPHRAGM RETAINER
DWG# 20423
SBE# 23411
DO ACCESS CAP
DWG# 20475
SBE# 23459
2-022 O-RING
SBE# 30074
CONNECTOR (MOD.)
DWG# 20420
SBE# 23409
2-213 O-RING
SBE# 30082
2-017 O-RING
SBE# 30072
P_ENUM
DWG# 20429
SBE# 23413
YSI SENSOR (MOD.)
DWG# 20421
SBE# 23414
2-014 O-RING
SBE# 30441
D.O. MEMBRAIN
SBE# 24110
D.O. END CAP
DWG# 20422
SBE# 23410
SEAL SCREW
SBE# 24019
D.O. HOUSING
DWG# 20424
SBE# 23412
4-40 X 1/2 SH 4 PL
SBE# 30440
4-40 X 7/16 FH 3 PL
SBE# 30127
2-019 O-RING
SBE# 30073
2-024 O-RING
SBE# 30463
SEA-BIRD ELECTRONICS, INC
YSI D.O. SENSOR ASSY.
40356

YSI 5700 SERIES DISSOLVED OXYGEN PROBES INSTRUCTIONS

The probes described in these instructions are designed for direct use with all YSI dissolved oxygen meters. 5700 Series probes are polarographic sensors. A thin permeable membrane stretched over the sensor isolates the electrodes from the environment, but allows gases to enter. When a polarizing voltage is applied across the sensor, oxygen that has passed through the membrane reacts at the cathode, causing a current to flow.

The membrane passes oxygen at a rate proportional to the pressure difference across it. Since oxygen is rapidly consumed at the cathode, it can be assumed that the oxygen pressure inside the membrane is zero. Hence, the force causing the oxygen to diffuse through the membrane is proportional to the absolute pressure of oxygen outside the membrane. As the oxygen partial pressure varies, both the oxygen diffusion through the membrane and the probe current changes proportionally.

YSI 5739 DISSOLVED OXYGEN PROBE

The 5739 probe system consists of the probe body plus a detachable cable (see Figure 2). The detachable cable is a convenience feature that facilitates changing cable lengths and replacing damaged cables or probes. The probe and cable assembly is held together with a threaded retainer. The assembly is not intended for casual disconnection; cable and probe should be separated only when necessary.

To detach the cable, unscrew the retainer and slide it down the cable to expose the connector. Pull gently on the connector until it comes away from the probe body. If the O-ring is frayed or damaged, replace it: a replacement O-ring is supplied with each 5740 cable. Reassemble by pushing the connector into the probe body, rotating it until the two halves mate. A light coating of silicone grease on the O-ring will make reassembly easier. Be sure the connector is dry; otherwise, erratic readings may result. Screw on the retainer finger-tight only.

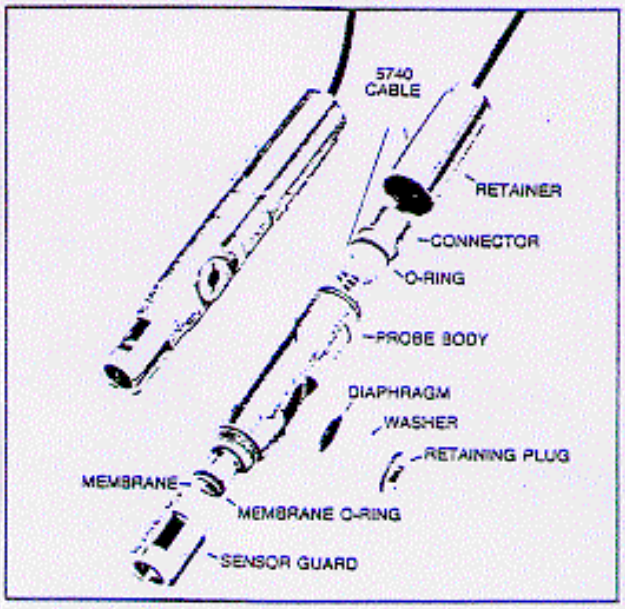


Figure 2. The YSI 5739 Probe

Pressure Compensation

The 5739 probe has a unique pressure compensating system that helps assure accurate readings at great depths. Pressure compensation is effective to 1/2% of reading with pressures up to 100 psi (230 feet of water). The compensating system does not normally require service and should not be taken apart. However, if electrolyte is leaking through the diaphragm, or if there is an obvious puncture, the diaphragm must be replaced. A spare is supplied with the probe. Use a coin to unscrew the retaining plug and remove the washer and diaphragm. Flush any salt crystals from the reservoir, install a new diaphragm if necessary (flat side out), replace the washer and securely screw in the retaining plug.

YSI 5750 BOD BOTTLE PROBE

The 5750 (Figure 3) is a non-stirring BOD probe. Agitation of the sample must be provided by other means, such as a magnetic stirrer.

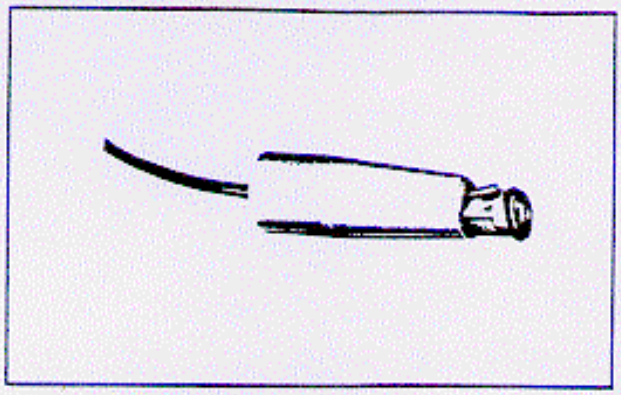


Figure 3. The YSI 5750 Probe

CHOOSING THE CORRECT MEMBRANE

An extremely thin membrane increases oxygen permeability and probe signal current, and hastens a probe's response; but it achieves this at the expense of ruggedness. The standard 1 mil (.001") membrane represents a compromise between quickness of response and membrane strength and integrity. (Order YSI 5775 Membrane and KCl Kit, Standard.)

For special circumstances, an 0.5 mil (.0005") membrane is available. (Order YSI 5776 Membrane and KCl Kit, High Sensitivity.) This half-thickness membrane hastens response at low temperatures and helps suppress background current at very low dissolved oxygen levels. (When data is routinely collected with sample temperatures below 15°C and at dissolved oxygen levels below 20% air saturation, the low signal current resulting from the use of the standard membranes tends to magnify the probe's inherent constant background signal. Using the high sensitivity membranes in this situation will decrease the percentage of error due to the probe's background current.)

For long-term monitoring situations only, a half-sensitivity, double-thickness 2 mil (.002") membrane is available. (Order the YSI 5675 Probe Service Kit, which includes membranes, electrolyte, probe service tool and monitor service instructions for the 5739 probe.)

PROBE PREPARATION

All probes are shipped dry. You must follow these instructions when preparing a new probe or when changing membranes. Prepare the electrolyte by dissolving the KCl crystals which are supplied in a dropper bottle that should be filled to the neck with distilled water. Then, proceed as follows:

Preparing the 5739 and 5750 Probes

1. Unscrew the sensor guard (5739 only). Remove the O-ring and membrane, then thoroughly rinse the sensor with distilled water.

2. To fill the probe with electrolyte and install a new membrane, follow these steps:

a. Grasp the probe in your left hand. (See the sketches in Figure 4.) When preparing the 5739 probe, the pressure compensating port should be to the right. Successively fill the sensor body with electrolyte while pumping the diaphragm with the eraser end of a pencil or a similar soft, blunt tool. Continue filling and pumping until no more air bubbles appear. When preparing the 5750 probe, simply fill the sensor body until no more air bubbles appear.

b. Secure a membrane between your left thumb and the probe body. Add more electrolyte to the probe until a large meniscus completely covers the gold cathode. NOTE: Handle membrane material with care, touching it at the ends only.

c. With the thumb and forefinger of your other hand, grasp the free end of the membrane.

d. With a continuous motion, STRETCH it UP, OVER and DOWN the other side of the sensor. Stretching forms the membrane to the contour of the probe.

e. Secure the end of the membrane under the forefinger of your left hand while holding the probe.

f. Roll the O-ring over the end of the probe, being careful not to touch the membrane surface. There should be no wrinkles in the membrane or trapped air bubbles. Some wrinkles may be removed by lightly tugging on the edges of the membrane beyond the O-ring.

g. Trim off excess membrane with scissors or sharp knife. Check that the stainless steel temperature sensor is not covered by excess membrane.

3. Shake off excess KCl. On the 5739, reinstall the sensor guard. Place the probe in a humid environment until ready for use, and between measurements.

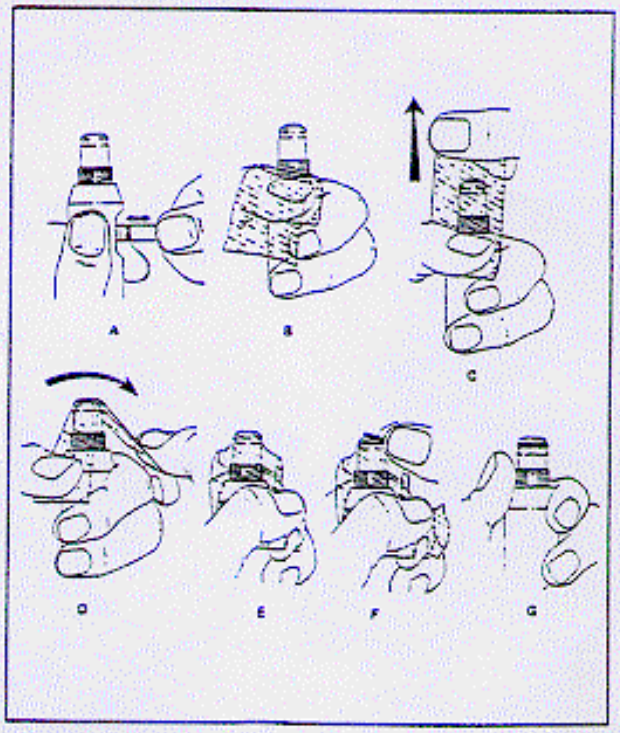


Figure 4. Membrane Application on the 5739 and 5750 Probes

ACCESSORIES AND REPLACEMENT PARTS

Accessories for the 5739 and 5750 Probes:

YSI 5680 Probe Reconditioning Kit. Includes a sanding tool and ten adhesive disks.

YSI 5775 Membrane and KCl Kit, Standard. Includes two 15-membrane packets (.001" thick standard FEP Teflon membranes) and a 30 ml bottle of KCl with Kodak Photo Flo.

YSI 5793 Membranes, Standard. Ten 15-membrane packets.

YSI 5776 Membrane and KCl Kit, High Sensitivity. Includes two 15-membrane packets (.0005" thick FEP Teflon membranes) and a 30 mL bottle of KCl with Kodak Photo Flo. Used for measurements below 15°C or for low oxygen levels

YSI 5794 High Sensitivity Membranes. Ten 15-membrane packets

YSI 5945-O-ring pack (Contains replacement sensor O-rings) for the 5739 and 5750

YSI 5986 Diaphragm Kit

YSI 5740 detachable cables; for the 5739 only:

YSI 5740-10, 10' cable YSI 5740-100,, 100' cable

YSI 5740-25, 25' cable YSI 5740-150, 150' cable

YSI 5740-50, 50' cable YSI 5740-200, 200' cable

YSI 5795A Submersible Stirrer with 50' combined probe and stirrer cable

YSI 5492A Battery Pack. Powers the submersible stirrer for use with the 50B, 51B, 54A, and 50B.

YSI 5721 Battery Pack. Powers the submersible stirrer for use with the 57 only. (Mounts inside the meter case.)

YSI 5075A Calibration Chamber

Accessories for the 5730 Only:

YSI 5732 Battery Adapter Cable (Direct connection with YSI Models 57, 58 and 59.) When used with the YSI 5492A, it is also applicable to YSI Models 50B, 51B and 54A.

YSI 5731 Membrane Assemblies (6) and KCl Kit, plus replacement sensor body O-ring.

PROBE SPECIFICATIONS

Cathode: Gold

Anode: Silver

Membrane: FEP Teflon (See "Accessories")

Electrolyte: Half saturated KCl

Temperature Range: -5 to 45°C; 15 to 35°C for the 5730 probe

Thermistor Accuracy: ±0.2°C

Temperature Compensation: (see instrument specifications)

Polarizing Voltage: 0.8 Volts (nominal)

Probe Current: in Air at 30°C: 19 microamps (nominal) in Nitrogen at 30°C: 0.15 microamps or less

Response Time: Typical response for dissolved oxygen, using standard membranes, is 90% in 10 seconds at a constant temperature of 30°C. Response at low dissolved oxygen levels is typically 90% in 30 seconds.

WARRANTY AND REPAIR

All YSI products carry a one-year warranty on workmanship and parts, exclusive of batteries. Damage through accident, misuse, or tampering will be repaired at a nominal charge, if possible, when the item is returned to the factory or to an authorized YSI dealer. Electrode cleaning is not covered by warranty.

If you are experiencing difficulty with any YSI product, it may be returned for repair, even if the warranty has expired. YSI maintains complete facilities for prompt servicing on all its products. This warranty is limited to repair or replacement (YSI's option) at no charge.

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