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DISSOLVED OXYGEN SENSOR LIFE EXPECTANCY
SBE 13/22B/23B/30B ("Beckman" type)

Note: This Application Note does not apply to the SBE 43 Dissolved Oxygen Sensor.

This application note summarizes the material on sensor performance tests and other life-expectancy-determining criteria found in the Beckman 'MINOS DOM' (Dissolved Oxygen Monitor) manual published in 1971. MINOS DOM was a complete DO profiling instrument including pressure, temperature, and DO sensors as well as a single-conductor cable telemetering system and surface readout. Although this instrument is no longer available, the DO sensor (now manufactured by SensorMedics Corporation) upon which it was based continues to be used on modern CTD equipment. The original Beckman descriptions are therefore applicable. Some additional material based on Sea-Bird's experience is included in this note.

SENSOR MODULE LIFE EXPECTANCY BASED ON ELAPSED AND DEPLOYMENT TIME

Storage Life. Beckman gives a 'storage life' of 12 months for sensors stored in their sealed pouches (these sensors are typically received at Sea-Bird within 1 month of their manufacture and are in our inventory for less than 2 months). The meaning of 'storage life' as used by Beckman seems to be that the sensor can be considered 'new, unused' during the storage period. We believe that the 12-month storage life is a very conservative figure and that the sensor can be considered 'like new' for 2 years or more if properly stored.

Dryout Time. Failure can be caused by drying out of the sensor electrolyte; however, the sensor will not dry out if maintained in a 100% relative humidity environment. This environment can be achieved with Sea-Bird sensors by either 1) installing the red protective cap after placing a few drops of fresh water inside (unpumped sensors); or 2) connecting plastic tubing partially filled with fresh water from the inlet to the outlet port (pumped sensors with clear plastic manifolds).

If the sensor is not kept in a 100% relative humidity environment, the dryout time can be calculated as:

minimum dryout time = 180 days x 100%/(100% - relative humidity)

For example, dryout time will be at least 360 days at 50% relative humidity.

Electrolyte Depletion. A final cause of sensor failure occurs as a result of electrochemical depletion of the sensor electrolyte as follows:

sensor life = 2160 hours/(PO_2)

Where PO_2 is the partial pressure of oxygen (in units of absolute atmospheres, i.e., 0.2095 or 159/760 mm Hg for dry air) in the environment being monitored. This gives a sensor life *in terms of actual powered operation* of 10,324 hours (well over 1 year at 100% air saturation).

SENSOR MODULE REPLACEMENT BASED ON SENSITIVITY

Beckman states that '...when continuously exposed to air or water, the sensor output gradually decreases to a point at which the (sensor) cannot be properly calibrated' and suggests that a 'rate of span loss of 2% per day' indicates that the sensor's electrolyte is nearly depleted and that the sensor should be replaced. In Sea-Bird's experience, use of the 2%/day criteria gives poor results because the sensor is failing so quickly; it is better to make an end-of-life judgment based on absolute sensor sensivitivity. A good rule-of-thumb is to replace the sensor when the Soc value obtained with air-saturated-water calibration reaches 4.0.

An oil film on the membrane will cause a reduction in output indistinguishable from sensor aging, so it is important that the sensor be kept clean.

SENSOR MODULE REPLACEMENT BASED ON SPEED OF RESPONSE

Typical response time is cited by Beckman as 'less than 6 seconds for 95% of the total response to a step change in oxygen concentration at 70 ^{o}F (21.1 ^{o}C)'. Since 95% of total response is the level reach in 3 'time constants', the 'time constant' for the sensor may be said to be 2 seconds. Beckman specifies the 95% response time at 32 ^{o}F (0 ^{o}C) as 18 seconds, so the time constant at this temperature will be 6 seconds.

Beckman states that a sensor whose 95% time response has decreased to 8 seconds at 70 ^{o}F should be replaced. They recommend using ambient air and an oxygen-free inert gas (usually nitrogen) to judge the time response. While the *increase* in response time is probably a valid indicator of the sensor's approaching end-of-life, most users will find it awkward to perform the necessary measurements.

SUMMARY OF RECOMMENDATIONS

1. Keep the sensor in a moist (100%) environment when not deployed. Air exposure for a few hours between casts will cause no significant shortening of life, however.

2. Keep the sensor membrane clean by rinsing it with Triton X-100 (liquid detergent).

3. Perform monthly or pre-deployment calibration checks using air-saturated water and sodium sulfite (see AN 13-1 for a description of this procedure). When Soc (as determined using the Sea-Bird OXFIT routine) reaches 4, replace the sensor. In our experience, this replacement will usually be required between 1 and 2 years after first deployment.

4. Routinely replace the sensor module (the brown-colored part containing the membrane) after 2 years service. The remainder of the sensor assembly (receptacle) has an unlimited operating life.