SPECTROCHEM INSTRUMENTS PVT. LTD.

DO measurement & control

Instrumentation through innovation

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SPECIAL POINTS OF INTEREST:

Cell chemistry

INSIDE THIS ISSUE:

A bio-technology news letter

In our first news letter, the importance of dissolved oxygen for the cells is highlighted under the title **Respiration**.

Dissolved oxygen is defined as the measure of water quality indicating free oxygen dissolved in water. Total aquatic life is dependent on this source of oxygen for its existence and proliferation. The units of measurement for DO are milligrams of O_2 per liter or expressed as parts per million (PPM). The solubility of O_2 in fresh water under equilibrium with atmospheric air is 8 PPM at ambient temperature of 25^0C-28^0C in India. The lowest oxygen level is expected at 100^0C and theoretically it is taken as 0 ppm and at 0^0C under ideal conditions. The max value can be of the order of 16ppm. The solubility of the dissolved oxygen is proportional to the temperature and pressure of the water.

The most common application of DO measurement occurs in waste water treatment. Biochemical breakdown of sewage is achieved by using bacterial activity. The availability of oxygen to the beneficial micro organisms or its absence for the filamentous **microbes** to proliferate is a key factor in Bio-remediation of waste waters.

Similarly Bio-Engineering and processing where in culture is involved, the role played by the oxygen and the quantification is of utmost importance.

Sensor Design:
Typical DO measuring instruments use a membrane type sensor. The membrane type sensors contain three basic features. The Electrodes, The Electrolyte and a membrane which is permeable to gaseous oxygen.

Electrodes: The electrodes provide the necessary reaction site for reduction of oxygen.

Membrane: The gas permeable membrane is designed to keep the electrolyte around the electrodes while allowing only dissolved oxygen to diffuse into the measurement cell.

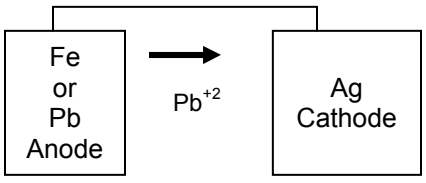
Electrolyte: The solution facilitates the migration of dissolved oxygen and provides an electrical path to complete the electrical circuit. The electrolyte must be periodically replaced to ensure that the system remains clean.

The operational details of the membrane sensor is that the oxygen in the water diffuses through the membrane into the electrolyte. The gas concentration tends to an equilibrium on either side of the membrane,

When ever it is not equal the oxygen diffuses from higher to lower concentration.

Cell Chemistry:

In case of galvanic cells



We provide user the choice of electrodes from ....

PHOENIX ELECTRODE COMPANY

HAMILTON THE MEASURE OF EXCELLENCE™

METTLER TOLEDO

We are the ony company in India providing the user choice of polorographic and galavanic probes

Our sensor electronics once configured at factory requires no further adjustment. Even calibration of sensors is a unique process. The embedded microcontroller card stores the calibration data in a non volatile EEPROM which can retain data for over 10 years.

A. *Galvanic Cell* :

A Galvanic cell operates like a battery. Two electrodes of dissimilar metals are dipped into an electrolyte. This causes an electrochemical reaction to take place when the oxygen comes in contact with electrodes.

At the cathode the oxygen is reduced to hydroxide releasing four electrons for each molecule of oxygen. These electrons cause current to flow through the electrolyte, the magnitude is proportional to the oxygen concentration in the electrolyte. As the oxygen is depleted in the electrolyte due to the concentration gradient oxygen diffuses across the membrane and equalizes the concentration.

Reaction at Cathode

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

Reaction at Anode

$$2Me \rightarrow 2Me^{2+} + 4e^-$$

The conventional galvanic cell has some inherent disadvantages.

- The reduction process is prone to interference due to contamination of electrolyte etc, i.e., a shift of the cell potential due to interferences.
- Low oxygen levels measurement is prone to errors due to low signal to noise ratio.
- The anode is constantly eaten away in the reaction process.

Our state of art signal conditioning card for pH, DO, three temperature probes. The board also has signal conditioning circuitry for dual pressure sensors.

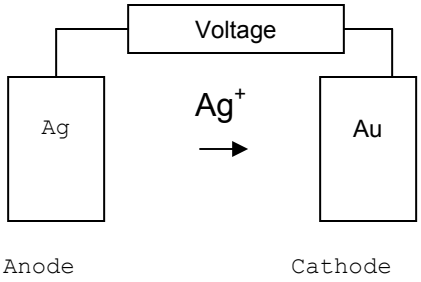
Unique features of our integrated signal conditioning card

- Triple input stage galvanic isolation for pH, DO & temperature.
- Double output stage optical isolation for pH & DO.
- Three independent DC-DC converters on board
- Based on legendry Burr-Brown operation amplifiers
- International WAGO connector assembly

B. *Polorographic cells*:

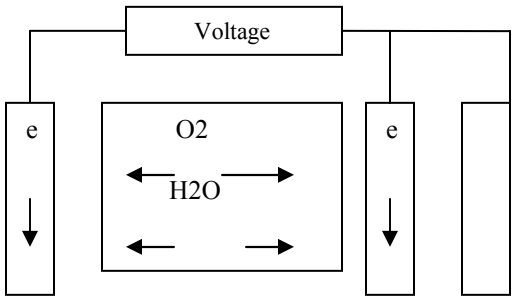
A Polorographic DO cell is an improvement over galvanic cell to some extent. In Polorographic cell a polarization potential is applied to the Electrodes

As long as the applied potential exists the cell is not influenced by **contaminants** in the electrolyte. In Polarographic cell also the current flow as a result of the oxygen reduction is measured. Since the current flow is proportional linearly to the diffusion of oxygen, errors at low level are reduced. Also there is no consumption of the electrode material takes place.



C. *Three electrode Polorographic cell:*

In this configuration an additional platinum electrode is employed as a counter electrode. The electrode configuration is a platinum working electrode (cathode) a platinum counter electrode (anode) and a silver reference electrode.
The oxygen that is dissolved in the process diffusing through the membrane and is reduced at the working electrode. The reverse of the reaction takes place at the counter electrode.
With this three electrode design the cell will remain at a constant potential even if there is a change in electrolyte resistance. The maintenance is minimum and even partial fouling of the membrane will not affect the cell performance. So the membrane life is extended and electrolyte depletion does not take place.



Whatever be the cell configuration, the DO measurement in somewhat troublesome and standardization is not a straight forward proposition. In most cases the zero level is fixed by dipping the electrode into a Sodium sulphite solution where the oxygen valve is zero. Then the electrode is lifted into moist air and the saturation is taken as 100%. The scale is set between these two values and % value or PPM(0–16) is read.

Our signal conditioning card supports both galvanic as well as polorographic DO probes.

Reaction at Anode: $2H_2O$ à $O_2 + 4H^+ + 4e^-$

Reaction at Cathode: $O_2 + 4H^+ + 4e^-$ à $2H_2O$

Net Reaction = Zero

Our signal conditioning card supports any electrode, any brand.

The user can himself replace the electrode, carry out our unique electronic calibration procedure without opening the unit or adjusting any POT's

***Control*:**

Since solubility is the criteria for the oxygen level in water, soluble substances and their concentration in the process fluids influence the terminal oxygen value (i.e., DO level as measured). Also pressure and temperature also play an important role in the solubility of oxygen in fluids. Control is achieved by constantly pumping air into the liquid and spraging. Also agitation of the medium to effect perfect mixing and distribution influence DO measurement. To obtain a steady value it is ways better to stop aeration and agitation during the measuring and integration period. The system can be restored after reading.

In our next issue:
Temperature and its control

We also offer projects for biotechnology students in reactor design, process control, fermentation, DSP,

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