

Oxygen (O_2) that is dissolved in an aqueous solution is called dissolved oxygen (DO). Oxygen diffuses into water through contact with the surrounding air or as a waste product of photosynthesis from aquatic organisms. Dissolved oxygen concentration plays an important part in whether or not a body of water can support aquatic life, but is also monitored in many different processes including wastewater treatment, winemaking, pulp and paper milling, maintaining boilers and cooling towers, environmental monitoring and many other industrial applications. Some of the factors that can influence concentration levels include:

- **Temperature** – As temperature decreases, more O_2 is able to be dissolved.
- **Water Velocity** – In fast moving water, the water is aerated by bubbles as it is churned allowing for more O_2 to be dissolved.
- **Atmospheric Pressure** – O_2 is more easily dissolved at lower altitudes.
- **Dissolved and Suspended Solids** – The more dissolved and suspended solids there are in the water, the less O_2 can be dissolved. Because of this, salt water typically has lower dissolved oxygen levels than fresh water.
- **Aquatic Plants** – Plants release O_2 through photosynthesis and increase dissolved oxygen concentrations.

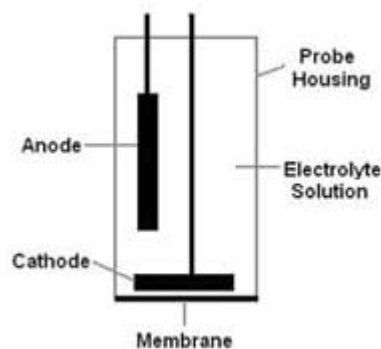
Nutrients and Organic Material – Plants and algae feed off of nutrients like nitrate and phosphate (commonly found in fertilizer and sewer runoff). When nutrients enter a body of water, plant and algae populations increase and when these populations die off, the dead organic matter is decomposed by microorganisms that use up O_2 . This can sometimes cause dissolved oxygen levels to drop too low for aerobic organisms, like fish, to survive.

There are two main ways to measure dissolved oxygen in water. One is through a titration

(Winkler Method) which involves using reagents and a color indicator to find the amount of titrant needed to get a color change, which can be converted into a dissolved oxygen level. The other method is using a dissolved oxygen meter and probe.

Dissolved Oxygen Probes

Most dissolved oxygen probes consist of a cathode, anode, electrolyte solution and a gas permeable membrane. The cathode consumes (reduces) oxygen, which creates a partial pressure across the membrane and causes oxygen to diffuse through the membrane into the electrolyte solution. The diffusion current is measured and then converted into a dissolved oxygen concentration.



Polarographic Probes are the most common type of dissolved oxygen probes. They consist of a silver anode and a gold or platinum cathode immersed in a potassium chloride electrolyte solution. These probes have a difference in potential of -0.5V or less between the anode and cathode and require an external power source (the meter) to polarize the probe to allow for the reduction of oxygen. This means that each time the probe is powered on; it needs to polarize before taking measurements which takes at least 10 min. If the power is cut, the user must wait for the probe to re-polarize when turned back on. Since these probes consume oxygen, they also need to have a constant

flow of the sample liquid across the membrane in order to get accurate results (this usually involves stirring the probe in the sample). With heavy use, polarographic probes need to be maintained every few weeks by changing the membrane and electrolyte solution. Eventually the anode will also need to be cleaned as it will become covered with silver chloride from the chemical reaction. These probes also need to be stored wet (usually in tap water or against a wet sponge), so the electrolyte solution does not dry up.

Galvanic Probes are very similar to polarographic probes, but the anode and cathode consist of two dissimilar metals which have already have a difference in potential greater than -0.5V. This means that there is no need for an external power source and they are self polarizing (do not need to be charged before use). Galvanic probes are also much more stable and accurate at lower dissolved oxygen levels and they will operate longer without electrolyte or membrane replacement.

Probe Membranes come in different thicknesses and materials. As the thickness of the membrane increases, the response time increases but the flow dependence decreases (meaning it will take longer to get your measurement but you won't have to stir the probe as much to get accurate results). Most membranes are made with a polyethylene material, but some are made with PTFE resin which helps provide superior fouling resistance, but has greater flow dependence.

Optical Probes are very different than polarographic and galvanic probes. They contain a fluorescing material, contained within an optical window, which becomes excited when controlled wavelength of light is aimed at it. The excited material then emits a specific intensity of light dependent on the amount of dissolved oxygen in contact with the optical window. This intensity is measured and then converted into a

dissolved oxygen concentration. Optical probes are much easier to maintain because they have no membranes or electrolyte solutions that require replacement and the measurement of oxygen is unaffected by water flow or pollutants, so there is no need for stirring and this can be used in almost any liquid, unlike polarographic and galvanic probes.

For information on calibration, storage and maintenance of pH probes, see the [Calibration and Maintenance of Water Quality Meters Tech Info Doc.](#)

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