Barometric Pressure

What is barometric pressure?

The layer of gases that makes up Earth's atmosphere is a number of miles thick. Gravity causes this layer of gases (i.e., air) to be quite heavy - about 15 pounds per square inch of horizontal cross-section at the Earth's surface. We would feel this weight like a stack of bricks on our head except that a body of air, like a body of water, produces fluid pressure that acts in all directions. Probably the only time we are aware of this pressure is when it is not balanced within our bodies - across our eardrums when landing in an aeroplane, for instance.

Fluid pressure caused by the weight of atmospheric gases is called atmospheric, or barometric, pressure. Barometric pressure is primarily determined by the thickness and density of the atmosphere above a given point on Earth. Normal sea level barometric pressure is 760 millimetres of mercury (760 mm Hg, about 15 psi).

How is barometric pressure measurement useful in water quality monitoring applications?

Barometric pressure has several implications in water quality monitoring. First, barometric pressure can determine the extent to which atmospheric gases can be dissolved in water. Generally, the sum of the "partial" pressures of the different gases in equilibrium solution equals the barometric pressure at the surface; higher barometric pressures support higher levels of dissolved gases in water. Less atmospheric gases can be dissolved in water in Denver than in San Diego or Miami because Denver, being a mile higher than coastal cities, has a thinner atmosphere and so a lower ambient barometric pressure.

Second, barometric pressure measurement is important in calibrating dissolved oxygen sensors. The atmosphere is roughly 20% oxygen (and 80% nitrogen), meaning that under equilibrium conditions approximately 20% of the gases dissolved in water is oxygen. So when a dissolved oxygen sensor is calibrated in air-saturated water (or water- saturated air), the barometric pressure must be known in order to calculate the equilibrium concentration of oxygen that will be used for setting calibration. Lower barometric pressures imply lower equilibrium oxygen concentrations. After calibration, changes in barometric pressure do not affect concentration readings (i.e., milligrams per litre or parts per million measurements), but do affect percent saturation readings. Post-calibration changes in barometric pressure may be used to correct percent saturation readings.

And third, barometric pressure measurement is often useful when monitoring water (hydrologic) level with electronic pressure transducers. These sensors, when not equipped with a venting tube, cannot distinguish between changes in water pressure (i.e., water level) and changes in barometric pressure, since the transducers are measuring the total of water and air pressure. For instance, a storm event might lower ambient barometric pressure by 20 millimetres of mercury. As a result, an uncorrected electronic pressure transducer would erroneously report a fall in water level corresponding to a pressure change of 20 millimetres of mercury (about 10 inches of water), though the water level may not have changed at all. Measurement of barometric pressure allows either real-time correction or post-correction of level measurements.

How is barometric pressure measured?

The traditional method for barometric pressure measurement is the barometer: a glass tube is sealed at the top, evacuated, and placed in an open pool of mercury. The mercury is forced into the tube by the atmospheric pressure exerted on the pool of mercury. Barometric pressure is measured directly as the height of mercury in the tube. Changes in barometric pressure cause changes in the height to which the mercury rises in the tube.

A more modern method for barometric pressure measurement is the electronic pressure transducer. In this device, the electrical

characteristics of a silicon wafer bonded to a metal diaphragm change according to the shape of the diaphragm. If a force (for instance, barometric pressure) is exerted on one side of this diaphragm, the diaphragm changes shape slightly, causing a commensurate change in the electrical characteristics of the wafer. An electronic circuit measures that change, and calibration converts the electrical signal to a pressure measurement in engineering units.

It should be noted that barometric pressure is reported in two ways.
First is absolute barometric pressure - the pressure exerted by the atmosphere compared to a vacuum. Second is corrected barometric pressure - absolute barometric pressure as measured at any altitude, but adjusted to be the measurement that would result from measuring pressure exerted by an air column of similar density if that air column extended exactly to sea level. Most weather forecasts give barometric pressure corrected to sea level, but dissolved oxygen calibration and level-measurement correction require absolute barometric pressure measurements.

Absolute barometric pressure (BP, mm Hg) can be estimated from corrected (to sea level) barometric pressure (SLBP, mm Hg):

where A is the altitude in feet above sea level.

How is barometric pressure measurement implemented in Hydrolab instruments?

Hydrolab measures absolute barometric pressure directly with an electronic pressure transducer mounted in the Surveyor® 4 Data Display. The Surveyor 4 uses the barometric pressure measurement for automatic calculation of dissolved oxygen calibration points. And, the barometric pressure measurement can be logged by the Surveyor 4 for use as a retrospective correction for exacting water level and/or for total dissolved gas measurements (like dissolved oxygen percent saturation sensor calibrations, total dissolved gas sensor calibrations are valid only at the barometric pressure of calibration).

Hydrolab also measures barometric pressure indirectly by optionally venting electronic pressure transducers installed in the DataSonde 4 and MiniSonde multiprobes. With barometric venting, the level measurement is constantly corrected for barometric pressure as barometric pressure bears on the transducer's diaphragm from the side opposite that of the water pressure. Hydrolab's vented level transducer is custom-made for environmental severity; accuracy is ensured by careful circuitry design and extensive mathematical characterisation.

Should I consider Hydrolab barometric pressure measurement?

Hydrolab barometric pressure measurement provides these benefits:

- speeds accurate dissolved oxygen calibration because manual barometric pressure entry is not required;
- eliminates need to correct sea-level barometric pressures to absolute barometric pressures;
- provides data to correct hydrologic level measurements for the effects of changing weather conditions;
- provides data to correct total dissolved gas measurements for the effects of changing weather conditions;
- provides data to correct dissolved oxygen percent saturation measurements for the effects of changing weather conditions;
- provides a record of barometric pressures at remote field locations for post-correction of dissolved oxygen percent saturation, total dissolved gas, water level, or any other barometric pressure affected measurement.

The Hydrolab barometric pressure measurement provides the same reliability that Hydrolab instruments are known for, and carries up to five years of full factory warranty.

For more information on this or any Hydrolab application please contact Campbell Scientific (Canada) Corp. at (780) 454-2505.

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