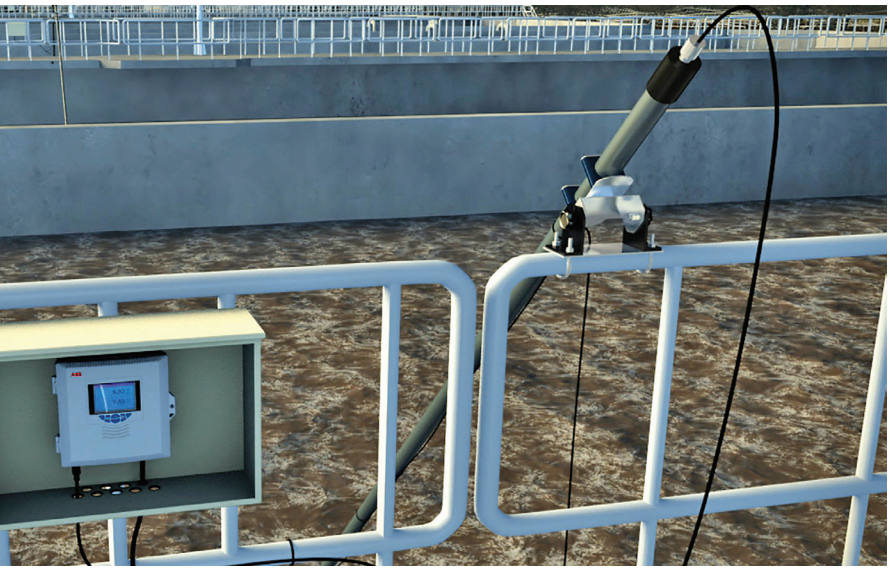
ABB MEASUREMENT & ANALYTICS | APPLICATION NOTE

The advantages of optical dissolved oxygen sensors

Optimize your aeration process using ABB's optical DO system



ABB's optical DO system

Save energy and cut operating costs using ABB's optical DO system.

Measurement made easy

Introduction

A typical wastewater treatment plant uses four main stages of treatment – Primary, Secondary, Tertiary and Sludge.

The secondary treatment stage is the point at which organic waste is oxidised to form carbon dioxide, water and nitrogen compounds. To achieve this, most modern plants use an activated sludge system, which uses a culture of bacteria and other organisms to feed on the organic materials in the sewage.

Dissolved oxygen is a crucial ingredient in the efficient digestion of organic material during the biological stage of the wastewater treatment. In the correct concentration and under the correct temperature conditions, dissolved oxygen helps to encourage the effective propagation of bacteria and other organisms in waste water, which then feed on the sewage waste, converting it into carbon dioxide, water and energy.

In many cases, the energy needed to power the equipment used to aerate secondary treatment processes can account for well over half of a plant's total energy costs.

The application

The oxygen needed for the aeration process is provided in one of two ways. Mechanical or surface aeration uses pumps or agitators on the surface of the tanks. The rate of aeration is controlled either by varying the speed and depth of the agitator, or the speed of the pump.

In contrast, the diffusion method uses perforated pipes or domes in the base of the aeration tanks. The supply of oxygen is varied by changing the speed of the compressors which force air through the diffusers.

In either case, accurate control of dissolved oxygen levels is critical to ensure the optimum conditions for the digestion process. If levels are too low, then the bacteria growth will be reduced, affecting the rate of sewage breakdown. If levels are too high, energy costs can increase and the effectiveness of the sensor can be impaired by the formation of slime.

For this reason, the recommended optimum level for dissolved oxygen is generally set at between 1.5 and 2 ppm.

The challenge

Conventional techniques used to measure dissolved oxygen, such as electrochemical or galvanic diffusion methods, have traditionally struggled to maintain accurate measurement over long periods of time without frequent recalibration due to sensor drift.

Drawbacks such as limited membrane life have made it difficult to achieve long-term accuracy and reliability. Moreover, the need for electrochemical sensors to be inspected, serviced and recalibrated, in some cases as often as every two weeks, adds to the overall cost of ownership.

Optical sensors have provided a much more stable measurement, but many types on the market are still slow to respond and require regular calibration due to degradation of the lumiphore material.

Measuring DO levels within an aeration process can prove a challenge in such a harsh environment. With high-fouling water and high sediment loads passing through the secondary stage at a rapid flow rate, the instrument needs to be robust and reliable.

In addition to this, installations can prove difficult as although the basic technology in aeration processes remain basically the same, the methods can vary from mechanical or surface aeration to diffusion. It can also be extremely inconvenient when a sensor needs to be frequently replaced. Finally, transmitter devices can be complicated to program and commission, with calibration details, serial numbers and lifetime indication requiring input.

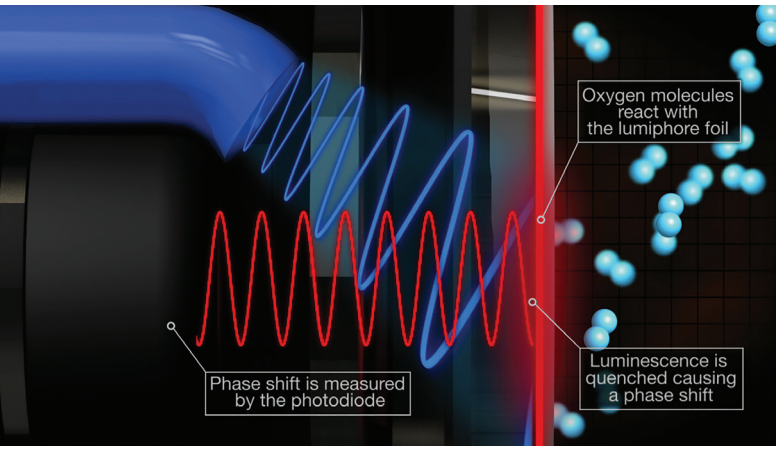


Figure 1 ABB's new ADS430 optical dissolved oxygen sensor uses the dynamic luminescence quenching

The solution

These problems are overcome by ABB's new ADS430 optical DO sensor, part of the Aztec range of advanced digital sensors.

Unlike other optical DO systems, the sensor can be deployed for extended periods of time without a need for calibration. Each sensor cap is individually calibrated and profiled to the lumiphore characteristics, which are continually monitored throughout the life of the sensor. This avoids the need for frequent recalibration.

Dissolved oxygen is measured using the 'dynamic luminescence quenching' principle.

The sensor's construction features lumiphore molecules embedded in a gas-permeable sensing foil element, a blue LED, a red LED, and photodiode. When the blue LED emits light, red photons are emitted, caused by excitation of the lumiphore molecules embedded in the gas-permeable sensing foil.

Any oxygen molecules present in the foil quench the luminescence, causing a phase shift in the returned red light which is measured by the photodiode. This phase shift is measured by comparing the difference between the original red reference light and the red light being returned. The higher the level of dissolved oxygen present, the lower the amount of red light is returned.

The DO concentration is calculated and relayed to the transmitter. The resulting information is then used to fine-tune dissolved oxygen levels to match the requirements of the process. By using the phase shift to measure the lifetime of the luminescence rather than its intensity, the sensor offers the highest accuracy and stability across the widest operating range.

As the patented signal processing is up to five times faster than other optical systems, improved control of dissolved oxygen levels can be achieved, enabling a return on investment in as little as six months.

Impervious to drift, the non-consumptive, non-reactive method is ideal for high-fouling environments and can withstand the harshest operating conditions.

What can ABB offer?

Comprised of a sensor and multi-channel transmitter, ABB's optical DO sensor system utilises the latest advances in optical measurement technology to give you the highest levels of stability and accuracy for dissolved oxygen measurement.

Figure 2 Problems with traditional dissolved oxygen sensing systems can now be eliminated using ABB's new optical DO sensing system

Available in two or four channel versions, the AWT440 universal transmitter can be connected to up to four ABB digital sensors, enabling monitoring at multiple points without purchasing and installing separate transmitters. It features optional SD/USB ports for data storage and graphical trending whilst compatible with a range of communications, including Ethernet, Modbus and Profibus.

Setting up the transmitter and sensor is easy. Simply connect the sensor using ABB's EZLink connection and the transmitter will automatically configure the sensor set-up.

Added simplicity is provided by the sensor's smart sensing cap with automatic setup.

The SmartCap comes pre-loaded with factory calibration coefficients, serial number, lifetime indication, and manufacture date which are automatically uploaded to the ADS430 optical DO sensor.

The SmartCap is capable of up to 24 months of continuous operation, greatly reducing the requirement for maintenance. When the cap does need replacing, it will be as easy as the original installation – the calibration details will be pre- loaded and the transmitter will automatically recognise the new sensor.

When cleaning is necessary, it can be cleaned and redeployed without calibration.

For high-fouling applications, the sensor can be automatically cleaned using ABB's auto-clean system. This system periodically injects a high pressure burst of air across the sensor surface to remove any fouling.

The ADS430 sensor is available with a range of installation options, including dip mount systems, floating ball systems and chain mount immersion systems for open tank and channel installations, as well as a flow-through system for panel mount systems.

As a way of boosting performance whilst minimising energy costs, the optical dissolved oxygen system is ideal for large-scale municipal and industrial waste water treatment plants.

It could also be used in any application where water must be cleansed before re-entering the water cycle, including aquaculture, dam or discharge monitoring and in food and beverage production processes.

ABB has extensive experience in the design, manufacture and lifelong support of dissolved oxygen sensors for water, wastewater and process applications.

For more information, contact your local ABB sales representative.

Watch the video

AWT440 transmitter

ADS430 sensor

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