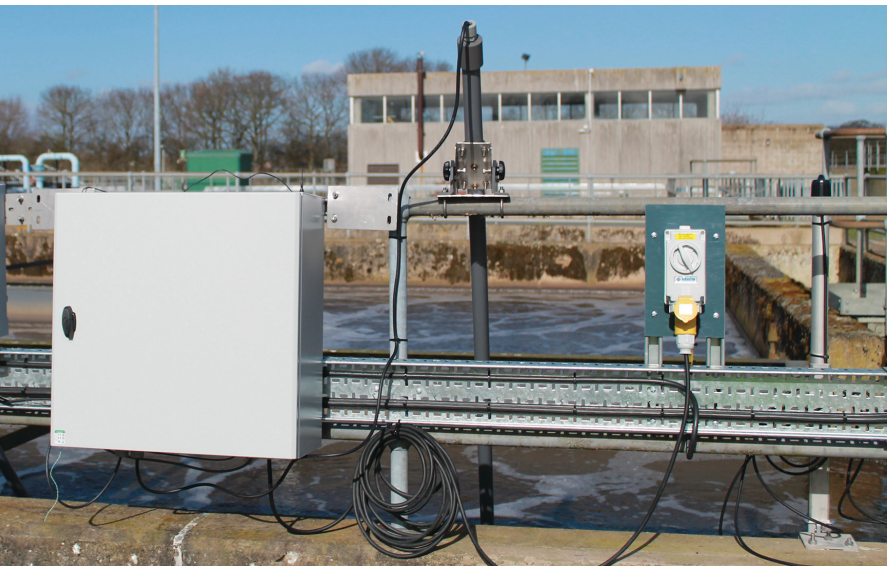
ABB MEASUREMENT & ANALYTICS | APPLICATION NOTE

ATS430 turbidity and TSS

Optimize your water discharge quality through accurate turbidity and suspended solids measurement



ABB'sATS430 turbidity and TSS system

Maintain regulatory compliance and eliminate measurement uncertainty using ABB turbidity and total suspended solids system.

Measurement made easy

Introduction

The clarity of water in a stream, river or ocean is a key determinant in fostering a healthy and balanced aquatic ecosystem. The clearer the water, the greater the ability of light to penetrate to aquatic plants which generate the oxygen needed for aquatic life.

Controlling the level of turbidity and suspended solids in treated wastewater discharged to the environment is therefore vital in preventing damage caused by depletion of dissolved oxygen levels. For this reason, turbidity and suspended solids concentrations of effluent discharges in particular are tightly regulated and need to be carefully monitored to ensure that regulatory limits are maintained.

In municipal wastewater applications, excessive levels of suspended solids can trigger a chain of events that can steadily deplete the level of oxygen in the water needed to sustain a healthy aquatic ecosystem.

As particles build up, they scatter the daylight passing through the water, reducing its strength. With less direct light available for effective photosynthesis, aquatic plants struggle to produce the oxygen needed for the survival of other aquatic life including fish, amphibians and waterborne insects.

Within the wastewater treatment plant itself, excess turbidity can also be indicative of a poorly operating treatment process. It is important to address this as residual suspended solids breaking through from sewage digestion processes will continue to have a biological oxygen demand as they enter the receiving water.

Controlling suspended solids is equally important in industrial wastewater applications, where there is the added risk of toxic or metallic compounds escaping into the environment.

The impact of rising populations and growing pollution from industrial activity are making it more important than ever to keep a check on what's entering the world's watercourses. With ever tightening legislation around water discharge quality, turbidity and suspended solids levels need to be carefully controlled in order to keep them within the required limits.

The application

Particles that are larger than two microns are generally considered to be total suspended solids (TSS). As such, suspended solids include silt, sediment, bacteria, clay, algae and non-settleable solids, all of which can affect the transition of light through water. Although some will naturally settle, over time, if flow conditions allow, some will stay suspended in the water.

As an optical determination of water clarity, turbidity provides an estimation of the total suspended solids in the water. Where turbidity is determined by the amount of light scattered off of these particles, it can be used to estimate the total suspended solids level. However it is important to note that other dissolved species such as dissolved organic matter may absorb light instead of scattering it, which can affect the accuracy of the determination.

Being able to establish a benchmark level of normal turbidity allows any deviations to be identified. With advances in monitoring technology, particularly those that provide continuous measurement, it is now possible to achieve a real-time picture of both turbidity and total suspended solids levels, allowing accurate detection and pinpointing of any deviations or irregularities. This information is useful both for discharge compliance monitoring and as a means of assessing the operational efficiency of waste water treatment processes

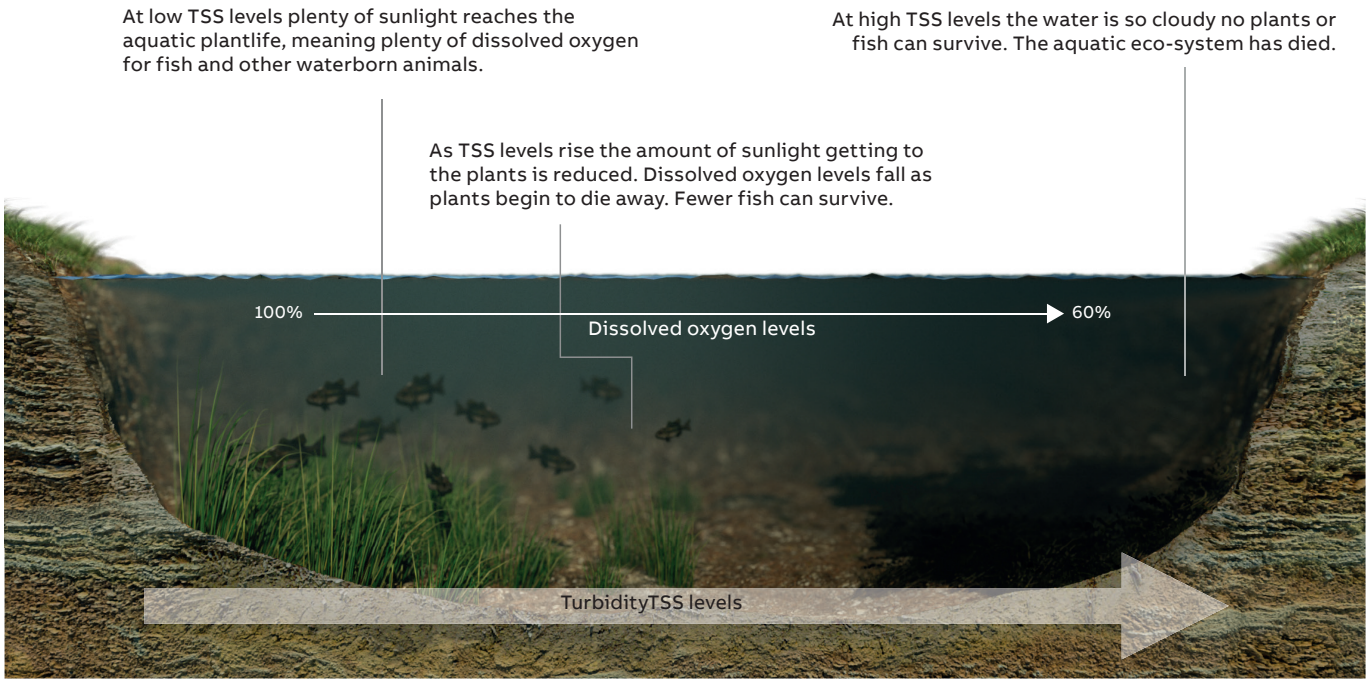


Figure 1 Controlling turbidity and suspended solids in treated wastewater helps prevent damage caused by depletion of dissolved oxygen levels

The most widely accepted method for measuring turbidity is to measure light scattered at a certain angle. This is normally 90 degrees in order to reduce the effect of stray light and absorption. The turbidity of a sample is measured as the intensity of light scattered by the material suspended in the sample. The scattered light intensity itself is proportional to the number of suspended particles, or suspended solids. Based on this relationship, it is possible to infer the mass of suspended particles for a given level of turbidity.

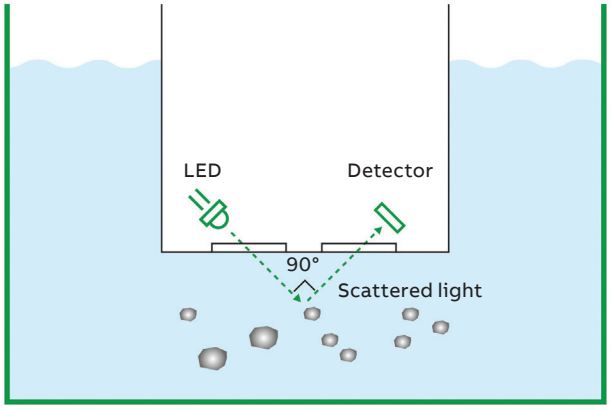


Figure 2 The most widely accepted method for measuring turbidity is to measure light scattered at a certain angle, most normally 90 degrees

To measure the concentration of suspended solids in a sample of turbid water, all that is needed is to produce a calibration curve that relates the mass of suspended solids to the turbidity. In a typical installation, a grab sample will be taken from the process water and the turbidity reading recorded. The suspended solids content will then be measured using a laboratory-based gravimetric procedure in accordance with ASTM method D5907-10. In this procedure, the suspended solids are filtered from the water before being dried and weighed. The resulting value, which is the total suspended solids level in mg/l, is used to calculate a conversion coefficient for the relationship between the turbidity and the suspended solids concentration.

The challenge

Although the procedure described in the previous section is useful in quantifying a relationship between total suspended solids and turbidity, a single sample is of limited use as an indicator of overall conditions. As a one-off measurement, a single sample will only ever be indicative of a given set of conditions for a given period of time, which may not apply universally.

The need for laboratory-based testing also makes it impossible to achieve a real-time measurement of turbidity and suspended solids.

It is also important to note that suspended solids levels can vary independently of the turbidity measurement. Turbidity, which is measured in Nephelometric Turbidity Units (NTU), is a measurement of the impact of suspended solids on the passage of light through water. Total suspended solids, is a quantitative measurement of the concentrations of suspended particles in a sample. As such, there is no single way of recognising the differences in the size or composition of the suspended particles or their impact on the turbidity measurement.

A good example is to compare an equal quantity of coal dust and silt. Although both will have the same level of particles, the impact that these particles will have on turbidity will differ as they will scatter and absorb light in different ways.

Constant changes in the conditions being measured will have a direct impact on the calculation of the coefficients in the calibration curve. If the composition of the sample varies, then a new calibration will be needed.

Added complications can also arise where different instruments and measurement and reporting methods are used. Many instruments use different techniques for measuring turbidity, for example, such that no two devices will produce exactly the same result for the same sample. The two main standards governing turbidity measurement – USEPA Method 180.1 and ISO 7027 – also stipulate different approaches, such as different wavelengths and allowable scattering angles for light detectors, which can lead to variation of results.

Our solution

Developments in analytical measurement technology are helping to address the issues associated with obtaining a reliable measurement. ABB's ATS430 turbidity sensor, for example, uses the latest advances in optical measurement technology to deliver precise and ultra-stable measurement of turbidity and suspended solids concentrations up to 4000 NTU (Nephelometric Turbidity Units) or 100,000 mg/l.

The sensor uses internationally-approved nephelometric measurement technology in accordance with the ISO 7027 method to measure both high level turbidity and total suspended solids (TSS) content in the sample. A beam of infra-red light is emitted by an LED directly into the sample. The light beam is scattered by particles in the sample, and the scattered light intensity is measured by the sensor's photodetector positioned at 90 degrees to the light beam, with the resulting data then being relayed digitally to the transmitter. As there is a known relationship between the amount of solids in suspension and the turbidity of a sample, the turbidity reading can be used to provide a real time estimate of the level of suspended solids in the sample.

A key feature within the sensor is its adaptive TSS calibration function, which automatically updates the turbidity to TSS calibration coefficient every time an in-process calibration is performed.

Every time a new TSS calibration is completed, a new co-efficient is calculated as a weighted average of the current coefficient plus the new coefficient. The advantage of this is that the calculated TSS values follow changes in the process whilst smoothing out any sudden jumps that are likely to be due to unrepresentative sampling in obtaining the laboratory sample or laboratory errors in determining the TSS content of that sample.

Adaptive TSS calibration
The ATS430 includes an adaptive TSS calibration function, which automatically updates the turbidity to TSS calibration coefficient every time an in-process calibration is performed.

Obtaining a reliable turbidity to suspended solids calibration can be a laborious and time consuming process. In most cases, several measurements over a period of time will be needed to obtain a good estimate of the relationship between the suspended solids content and the turbidity of a water sample.

Traditional techniques have relied on the user to obtain a good representative calibration coefficient based on grab sample analysis. In reality, this is not practical, as it relies on historical data that may not match the current sample composition. This can cause sudden jumps in the inferred values of TSS when the change in coefficient is applied.

How Adaptive TSS calibration works
ABB's Adaptive TSS function technology addresses this by updating the coefficient progressively every time an in-process calibration is performed. In this way, the calibration coefficient follows changes in the sample composition, avoiding sudden shifts caused by non-representative sampling or incorrect laboratory results.

The ATS430's Adaptive TSS calibration function uses the reading for the turbidity of the sample gathered by the sensor to calculate an equivalent TSS value based on a weighted average of the historical coefficient plus the new co-efficient. The resulting TSS value is shown in Figure 3.

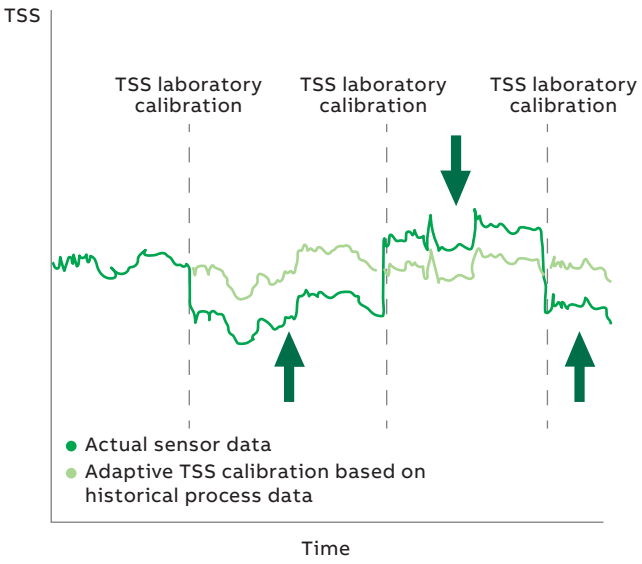


Figure 3 Actual sensor data with equivalent TSS value

How ABB can help

ABB's ATS430 turbidity and TSS probe with Adaptive TSS calibration provides operators with more reliable process data for improved process control and regulatory compliance.

The ATS430 is part of ABB's Aztec family of advanced digital sensors for monitoring the key parameters in municipal and industrial water and wastewater treatment.

Featuring ABB's EZLink technology, it provides ultra-stable and accurate measurement of turbidity and total suspended solids up to 4,000 NTU (Nephelometric Turbidity Units) or 100,000 mg/l. Unlike conventional turbidity and TSS sensors, the ATS430 requires no servicing throughout its operational life, enabling it to offer the lowest cost of ownership.

Figure 4 The ATS430 is part of the Aztec range of digital sensors for municipal and industrial wastewater treatment applications

One device for multiple industries
The ATS430 is suitable for use across a range of industries subject to regulatory effluent discharge consents, including:

- Potable water treatment
- Municipal / Industrial wastewater treatment
- Produced and flowback wastewater treatment
- Pulp and paper
- Food and beverage
- Marine
- Mining

Easy to set up and use
A major benefit of the ATS430 is its simplicity. The MCERTS-approved sensor comes pre-calibrated, making it ready to use as soon as it is taken out of the box.

Set-up is straightforward, with ABB's EZLink technology enabling quick connection to an EZLink-enabled digital universal transmitter, which automatically recognises and configures the sensor.

Once operational, all analysis and signal conditionong is performed within the sensor, with the resulting data relayed digitally to the transmitter.

With no need for wiring or complicated configuration, EZLink eliminates the time and cost associated with installation, including the requirement for a specialised engineer to get the ATS430 up and running.

Figure 5 ABB's EZLink technology enables the quick and simple connection of the sensor and digital transmitter

… How ABB can help

The lowest cost-of-ownership

The ATS430 also incorporates a number of features that help it to offer the lowest cost of ownership of any device on the market. Its fully-sealed design means there are no o-rings, seals or gaskets to replace, making it a truly service-free device. The sensor is also highly resistant to fouling, with a choice of polished stainless steel or corrosion-resistant titanium sensor bodies.

An added measure against high fouling environments is the inclusion of an optional automatic wiper on the sensor face, which helps to remove fouling from the scratch-resistant sapphire optical windows. If a wiper system is fitted, the ATS430 monitors usage and alerts the user when replacement is due. The wiper itself can be replaced in a matter of seconds, enabling the sensor to be put back into service quickly.

Downtime is further minimised by the provision of a sensor verification and calibration kit for the ATS430, which eliminates the need for the use of chemical standards that can be costly, hazardous and difficult to prepare. The kit comes with everything needed to calibrate and verify the sensor, including a range of different calibration discs that have been calibrated against primary turbidity standards at the factory. As the kit can be used across different ATS430 sensors and each calibration disk can be reused, it is extremely cost effective.

Accurate performance

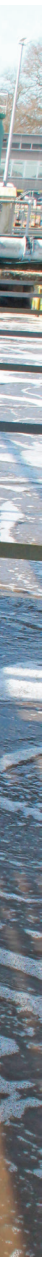
A key feature within the ATS430 is its innovative Adaptive TSS Calibration function, that provides a simpler, faster way of obtaining reliable TSS process calibrations and avoids sudden shifts caused by non-representative sampling or incorrect laboratory results.

Compact and flexible

The ATS430's compact 40 mm diameter size makes it ideal for a range of installation options. Using the integral thread, the sensor can be easily mounted to a pole system for open tank and channel installations, chain mount system or directly into a pipe or flow cell. This flexibility is further enhanced by the sensor's wide measuring range, together with its robust design, which is able to withstand temperatures up to 60 °C and pressures up to 10 bar. The option of a titanium sensor body also enables the ATS430 to be used in aggressive media and corrosive environments such as salt water.

Up to four ATS430 turbidity and TSS sensors can be connected to a single AWT440 universal transmitter, or can be mixed with other devices from the Aztec 400 range such as the ADS430 optical dissolved oxygen sensor. Available in two or four channel options and with a choice of communication protocols, the AWT440 enables monitoring at multiple points without the need for purchasing and installing separate transmitters.

Figure 6 With its compact design and range of mounting options, the ATS430 offers a number of installation possibilities



Key features at a glance

Easy to use
- EZLink automatic sensor recognition and set-up for fast and simple connection to an ABB EZLink-enabled digital transmitter
- Advanced predictive maintenance diagnostics
- Supplied factory-calibrated, ready for use

Accurate and reliable
- Choice of stainless steel or titanium sensor bodies
- Scratch-resistant sapphire windows
- Adaptive TSS calibration for improved control
- MCERTS approved

Lowest cost of ownership
- No servicing for the lifetime of the sensor
- In-situ cleaning
- Easy calibration and verification

Flexible installation options
- Pipe, tank, open channel or flow-cell options
- Suitable for use in salt water and corrosive media

Compact design
- 40 mm (1.57 in) probe diameter, ideal for a range of installations

ABB has extensive experience in the design, manufacture and lifelong support of analytical sensing and transmitter systems for water, wastewater and process applications.

For more information about the ATS430 or our range of other solutions for continuous water quality measurement, visit http://bit.ly/AztecATS430 or contact your local ABB sales representative.

Figure 7 The ABB ATS430 turbidity and TSS system offers the simple solution for wastewater discharge monitoring applications

Interactive guide

Animation

White paper

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