Application Note 021

Measuring Suspended Solids in Water/Wastewater

Water Analysis Instruments, Thermo Fisher Scientific

Key Words

suspended solids, total suspended solids, water and wastewater treatment, water quality, turbidity, online measurement, sediment, process, monitoring, Thermo Scientific™ AquaSensors™ DataStick™

Goal

This application note explores the topic of suspended solids and total suspended solids, including how and why they are measured in water and wastewater treatment processes.

What are Suspended Solids and Total Suspended Solids?

Measuring suspended solids in water is used for control of various treatment processes and for examination of wastewater quality. The level of suspended solids (or total suspended solids) in water and wastewater affect the quality of the water and how it can be used.

Why Measure Suspended Solids Online

Measuring suspended solids online allows for instantaneous monitoring and control of the process where the sensor is installed. Suspended solids measurements may be useful in any process where suspended solids are present or are removed, such as coagulation and flocculation, settling, clarification, precipitation, and filtration. Examples of applications include:

- In filtration processes
- Control of chemical doses for solids removal
- Correlation of process conditions vs. solids removal
- Verification of solids removal
- Alarms and shut down for out of control conditions
- Compliance with regulatory requirements

These applications are important in water treatment, wastewater treatment, water quality monitoring, industrial wastewater treatment, oil field water treatment, and similar markets and industries.

Measuring Total Suspended Solids in the Lab

Total suspended solids (TSS) is measured in laboratories by filtering a known volume of a sample, drying the filter and captured solids, then weighing the filter to determine the weight of the captured suspended solids in the sample. TSS is calculated as follows:

$$TSS\ (mg/L) = (Wfss - Wf)/Vs$$

Where:
Wfss: weight of filter with suspended solids
Wf: weight of the filter
Vs: volume of sample

The entire process takes about 2 hours (or more) and does not lend itself to instantaneous, continuous measurement. See ASTM D5907, EPA Method 160.2, Standard Methods 2540D or similar gravimetric method for details of the lab method.

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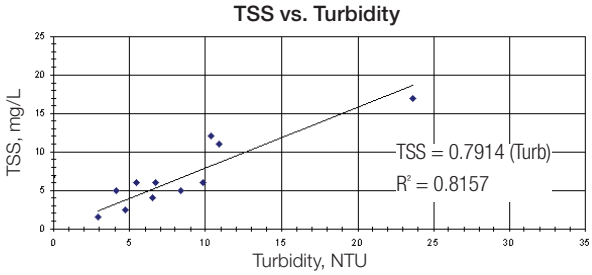
Measuring Suspended Solids Online

The presence of suspended solids (SS) in a sample affects the light scattering properties (the turbidity) of the sample. In general, the amount of light scatter is proportional to the amount of SS in the sample. Therefore, if we measure the turbidity (light scattering) of the sample, then we can relate it to the TSS/SS of the sample. The chart below shows an example of how turbidity and TSS may be related.



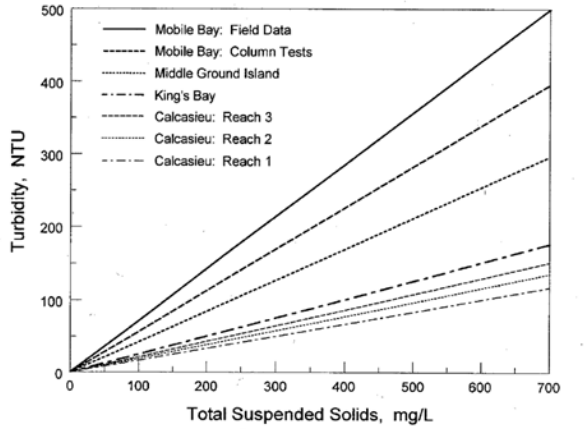
An untreated sample where the solids are still suspended will appear opaque (high turbidity). Conversely, the sample will be clearer (low turbidity) after treatment. In a settling treatment tank, the top portion of the sample will be clear. Installing a SS sensor at the top of the treatment tank or after the treatment process can give information about when the solids settling treatment is finished and/or how complete is the solids removal after the treatment. By choosing the location of the sensor and measuring the turbidity of the sample at that point, we can determine the SS instantaneously and continuously.

Factory Calibration of the Suspended Solids Sensor

Suspended solids sensors are typically factory-calibrated in units of mg/L or ppm by using suspensions of weighed solids in water. Diatomaceous earth (DE), primarily composed of silicon dioxide (SiO_2) is commonly used. DE is a historic standard used for turbidity calibrations and serves as a useful reference for suspended solids sensors. The Thermo Scientific AquaSensors Datastick Suspended Solids Measurement System is calibrated using DE.

Sample-Specific Calibration of the Sensor

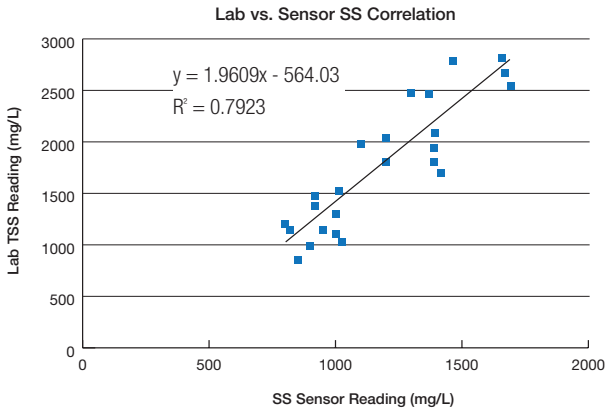
What happens when the sample or process being measured is not SiO_2 or DE, like the factory calibration? Since most samples are not exactly like SiO_2/DE, the results from the SS sensor will trend with laboratory TSS results, but may be biased high or biased low, depending on how the process sample differs from SiO_2/DE. Every sample stream can be expected to have its own light scattering properties, which can be correlated to its suspended solid content. The following chart shows how different samples can have different correlations between turbidity and suspended solids.



If it is desirable to match the online SS sensor readings to the laboratory TSS results, there must be a sample-specific calibration of the SS sensor. This can be done by generating a correlation or by a calibration update, according to user preference.

Options for Sample-Specific Calibration

Correlation method: Prepare a correlation between the lab TSS results and the online SS sensor results. To do this, collect samples at the SS sensor location. Note the SS sensor reading and send the sample to the lab for TSS testing. After repeating this process 10 – 20 times, graph the sensor reading against the lab results to make a correlation chart. The equation from the chart allows the sensor reading to be converted to an equivalent lab reading by calculation. A correlation chart might look like this:



Calibration update method: Perform a one-point calibration update of the sensor based on lab TSS results. Collect a large volume of sample. Send a portion to the lab for TSS testing. Store the rest at 6°C. When the lab results are available, warm the sample back up to process temperature, stir, and place the SS sensor into the sample. Perform a one-point calibration update by entering the lab TSS result into the calibration. After this calibration, the SS sensor should read a value similar to the lab results.

Which Sample-Specific Calibration is Better?

Preparing a correlation using multiple samples takes longer, but can account for effects such as daily or seasonal variations, temperature changes, and concentration changes. It depends on how many correlation samples are collected and what conditions are present when collected. In this way, using a correlation can be more accurate, when it is important to match sensor results to lab results.

Alternatively, performing a one-point calibration update can be faster and may be sufficient when the sample stream does not vary much and a tight agreement between sensor results and lab results is not required.

Interferences and Sampling Configuration

The AquaSensors Datastick suspended solids measurement system uses an infrared light-emitting diode (LED) light source and ratio-metric optical geometry in the sensor design. This means that interferences from color, other light-absorbing substances, and ambient light are minimized. Changes to the sensor optical windows tend to cancel out. The LED output is stable and does not require replacement or frequent recalibration. When installing the SS sensor, it should be placed to avoid trapping bubbles and avoid light reflections, which can interfere. Bubbles can occur when dissolved gases come out of solution due to an increase in water temperature or a decrease in water pressure. Pumping and sparging can also introduce bubbles. If sample stream velocity is too high, floc shear may occur (e.g. at the clarifier effluent) and affect the readings. Avoid placing the sensor where sediment may accumulate. Install an air or water purge wash system to keep the sensor cleaner for longer periods of time and reduce maintenance frequency.

Cleaning and Care of the Sensor

The LED light source of the AquaSensors DataStick suspended solids measurement system is robust, stable, and long lasting. It does not require replacement. When the wash hardware has been installed with the SS sensor, an air or water purge will help keep the sensor clean for longer periods. However, the sample can eventually coat and obscure the optical windows of the sensor and affect the performance. Periodically clean the sensor windows with a warm (not hot) 1% detergent solution and a soft brush to remove biofilm, grease, and oil. Do not use metal brushes or abrasive cleaners, which can damage the windows. If scale is present, remove by soaking in household vinegar (or acetic acid, up to 20%) for a short period, e.g. 1 hour. Then use a soft brush to remove the scale. After cleaning, it may be useful to verify the sample-specific calibration by sending a grab sample to the lab for testing.

References

ASTM D5907. www.astm.org

EPA Method 160.2. www.epa.gov

Standard Methods 2540D. www.standardmethods.org

TSS vs. Turbidity Chart: www.env.nm.gov

TSS vs. Turbidity Combined Regression Plots: https://clu-in.org

To purchase a Thermo Scientific AquaSensors DataStick measurement system, please contact your local equipment distributor and reference the part numbers listed below:

Product	Description	Part Number
Online Sensors	Thermo Scientific AquaSensors Datastick Suspended-Solids Measurement System	RTXXXX

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