Total Suspended Solids Sensor

A practical guide to total suspended solids sensor, covering the reader intent, the relationship to total suspended solids sensor, key evaluation criteria, common risks, and the information the intended project audience should confirm before taking the next step.

Main topic: Main Page
https://www.level-meters.com/

In industrial process control and wastewater management, monitoring the concentration of undissolved particulate matter is essential for operational efficiency and regulatory compliance. A total suspended solids sensor (TSS sensor) provides real-time data on the dry-weight of particles trapped by a filter, typically measured in milligrams per liter (mg/L) or grams per liter (g/L). Unlike turbidity, which measures light clarity, TSS is a quantitative measure of the mass of suspended solids.

For engineers and plant operators, selecting the right sensor requires a deep understanding of optical and ultrasonic physics, as well as the specific characteristics of the process media. This guide explores the fundamental principles, selection criteria, and installation best practices for industrial TSS monitoring.

Measurement Principles of TSS Sensors

Total suspended solids cannot be measured directly by a single physical constant because the particles vary in size, shape, and composition. Instead, sensors use surrogate physical properties—most commonly light scattering or ultrasonic attenuation—to infer the solids concentration.

Optical Scattering and Absorption

Optical sensors are the most prevalent technology for TSS measurement. They operate by emitting light (often in the near-infrared range to minimize color interference) into the medium and detecting how the particles interact with that light.

1. 90° Scattered Light (Nephelometry): This method measures light scattered at a right angle to the incident beam. It is highly sensitive and ideal for low to medium concentrations (0–1,000 mg/L).

2. Backscatter (135°–180°): For high concentrations where the medium becomes opaque, backscatter sensors detect light reflected back toward the source. This is effective for sludge and thick slurries where light cannot penetrate deeply.

3. Transmitted Light (Attenuation): The sensor measures the loss of light intensity as it passes through a fixed path length. Based on the Beer-Lambert law, the reduction in intensity correlates to the concentration of particles. This is often used in medium-range applications.

4. Multi-Beam Ratio Method: Advanced sensors use multiple detectors at different angles and distances. By calculating the ratio of these signals, the sensor can compensate for electronic drift, light source aging, and minor window fouling.

Ultrasonic Attenuation

In applications with extremely high solids content (e.g., primary sludge or mining tailings exceeding 50,000 mg/L), optical light is completely blocked. Ultrasonic TSS sensors emit high-frequency sound waves. The particles in the fluid absorb and scatter the acoustic energy. The degree of attenuation is proportional to the suspended solids concentration. This method is less affected by the color of the liquid but is sensitive to entrained air bubbles.

Key Selection Criteria for Industrial TSS Monitoring

Choosing a total suspended solids sensor depends on the expected concentration range, the chemical nature of the fluid, and the physical environment of the installation point.

Selection Table: Technology vs. Application

Feature	Nephelometric (90°)	Backscatter	Ultrasonic
Optimal Range	0–1,000 mg/L	1,000–50,000 mg/L	10,000–200,000+ mg/L
Accuracy	High at low ranges	Moderate	Moderate
Color Sensitivity	Moderate	Low	None
Bubble Sensitivity	High	Moderate	Very High
Common Use	Effluent monitoring	Activated sludge	Sludge dewatering

Process Conditions

When reviewing options on the Main Page, engineers must confirm the following process boundaries:

Particle Size and Shape: Optical sensors are calibrated to specific particle types. If the process involves significant changes in particle size (e.g., changing from flocculated to non-flocculated solids), the sensor may require recalibration.

Chemical Compatibility: Sensor bodies are typically constructed from 316L stainless steel, PVC, or Titanium. Ensure the O-rings (Viton or EPDM) and the optical window (Sapphire or Quartz) can withstand the corrosivity of the process.

Temperature and Pressure: Standard sensors operate up to 50°C (122°F) and 6 bar (87 psi). High-pressure variants are available for specialized industrial pipelines.

Installation Guidelines and Best Practices

Proper placement is the most critical factor in ensuring the reliability of a TSS sensor. Incorrect installation leads to representative errors, where the sensor measures a localized anomaly rather than the true process state.

Pipe Installation

For pressurized lines, sensors are usually installed via a T-piece or a hot-tap retraction assembly.

Flow Velocity: Maintain a velocity of at least 0.5 m/s to 1.5 m/s. If the flow is too slow, solids will settle out of suspension, leading to low readings. If the flow is too fast, cavitation may occur at the sensor head.

Orientation: Install the sensor on the side of a horizontal pipe (3 o'clock or 9 o'clock position). Avoid the top, where air pockets collect, and the bottom, where heavy sediment and grit accumulate.

Straight Runs: Ensure at least 5 pipe diameters of straight run upstream and 2 diameters downstream to minimize turbulence.

1

Tank and Open Channel Installation

In wastewater basins or open flumes, immersion sensors are used.

Submergence Depth: The sensor should be submerged at least 300 mm (approx. 12 inches) below the surface to avoid interference from floating foam or ambient light.

Wall Interference: Optical sensors should be kept away from walls and floors. A minimum clearance of 150 mm is generally recommended to prevent the light beam from reflecting off the structure.

Mounting Angle: Mounting the sensor at a slight angle (e.g., 45° to the flow) can help the flow of liquid naturally "sweep" the sensor face, reducing the accumulation of debris.

Limitations and Common Risks

While TSS sensors provide valuable real-time data, they are not "set and forget" instruments. Understanding their limitations prevents data misinterpretation.

1. Biofouling and Scaling: In biological wastewater treatment, biofilm can grow on the optical window within days. Even a thin layer of grease or calcium scale will drastically alter the light path. Automated cleaning systems, such as mechanical wipers or compressed air blasts, are essential for most industrial applications.

2. Air Bubbles: Small air bubbles act like solid particles to both optical and ultrasonic sensors. In aeration tanks, sensors must be placed in zones with minimal turbulence or equipped with de-aeration baffles.

3. Correlation with Gravimetric Analysis: A TSS sensor provides a signal that must be correlated to a laboratory "grab sample" (Standard Method 2540D). Because sensors measure optical properties and the lab measures mass, the correlation is only valid if the particle characteristics remain consistent. If the plant changes its chemical coagulant, the sensor's "slope" or calibration factor will likely need adjustment.

4. Color Interference: Although near-infrared (NIR) light reduces the impact of color, extremely dark or highly variable dyes in the water can still absorb light energy, leading to an overestimation of solids concentration.

Maintenance and Calibration Procedures

To maintain accuracy, a structured maintenance schedule is required.

Weekly Inspection: Manually check the sensor head for rags, hair, or grease buildup that the automated wiper might have missed.

Zero-Point Calibration: This is performed using deionized or filtered water. It ensures the sensor reads zero when no suspended solids are present. This should be checked monthly.

Slope Calibration (Field Calibration): This is the most important step. While the sensor is in the process, take a representative grab sample and immediately note the sensor's current reading. Once the laboratory results for that sample are returned, adjust the sensor's calibration factor to match the lab's mg/L value.

Frequently Asked Questions (FAQ)

Q: Can a TSS sensor measure dissolved solids like salt or sugar?

A: No. Total Suspended Solids (TSS) sensors only detect undissolved matter. For dissolved solids, a conductivity sensor or a Total Dissolved Solids (TDS) meter based on electrical conductivity is required.

Q: What is the difference between Turbidity and TSS?

A: Turbidity is an optical property indicating how much light is scattered (measured in NTU or FNU). TSS is a measure of the mass of solids per volume of water (mg/L). While they often trend together, the relationship changes if the particle size or density changes.

Q: How often should the sensor wiper be replaced?

A: In typical wastewater applications, rubber wiper blades should be replaced every 6 to 12 months. If the medium contains abrasive grit, more frequent replacement may be necessary to prevent scratching the optical window.

Q: Is it possible to measure TSS in oil-based liquids?

A: Yes, but it requires specialized optical sensors. Standard water-quality sensors may have seals or housings that degrade in the presence of hydrocarbons. Additionally, oil droplets themselves may be detected as "solids" depending on the emulsion state.

By carefully considering the measurement principle and environmental factors, industrial operators can implement a total suspended solids sensor that provides the reliable data necessary for process optimization and environmental protection.