

What Is Turbidity Sensor

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



Main topic: Main Page
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In industrial process control and environmental monitoring, understanding the clarity of a fluid is often as critical as measuring its level or flow. A turbidity sensor is an analytical instrument designed to measure the concentration of suspended solids in a liquid by quantifying its optical characteristics. Whether in a municipal water treatment plant or a complex chemical manufacturing facility, these sensors provide real-time data essential for maintaining product quality and regulatory compliance.

This article provides a comprehensive engineering overview of what is turbidity sensor technology, exploring its physical principles, hardware configurations, and practical application in industrial environments.

| The Principle of Turbidity Measurement

To understand what is turbidity sensor technology, one must first define turbidity itself. Turbidity is not a direct measurement of the weight of suspended solids; rather, it is an expression of the optical property that causes light to be scattered and absorbed rather than transmitted in straight lines through a sample.

| Light Scattering and Attenuation

When a light beam passes through a fluid containing suspended particles (such as silt, clay, organic matter, or microorganisms), the light interacts with these particles. This interaction results in two primary phenomena:

1. **Scattering:** Light hits a particle and is redirected at various angles.
2. **Attenuation (Absorption):** The intensity of the light beam decreases as it travels through the medium because the particles absorb some of the energy.

| Optical Geometries

Industrial sensors utilize different optical geometries depending on the expected concentration of particles:

Nephelometry (90° Scattering): This is the most common method for low-level turbidity (e.g., drinking water). The sensor places a detector at a 90-degree angle to the light source. This geometry is highly sensitive to small particles and is the basis for the ISO 7027 and EPA 180.1 standards.

Transmittance (180° Absorption): The detector is placed directly opposite the light source. The sensor measures the loss of light intensity. This method is more effective for highly turbid liquids where scattering becomes too complex to measure accurately.

Backscattering: The detector is placed at an angle greater than 90 degrees (often around 135° or 180° relative to the source). This is typically used for very high concentrations, such as sludge density monitoring.

| Technical Components of a Turbidity Sensor

A modern industrial turbidity sensor, such as those integrated into systems by professional manufacturers like Welk, consists of several core components designed for durability and precision.

| The Light Source

Most industrial sensors use either a Tungsten filament lamp (following US EPA 180.1) or an Infrared (IR) LED (following ISO 7027). IR LEDs, typically operating at a wavelength of 860 nm, are preferred in industrial B2B applications because they are less affected by the inherent color of the liquid, providing a more accurate measurement of particles alone.

| The Photo-Detector

These are semiconductor devices (photodiodes) that convert the received light energy into an electrical signal. In high-end sensors, multiple detectors may be used to compensate for fluctuations in light source intensity or window fouling.

| Signal Processing and Housing

The raw electrical signal is processed by internal electronics to provide a standardized output, such as 4-20mA, Modbus RS485, or HART. The housing is typically constructed from 316L stainless steel or corrosion-resistant plastics like PVC or PEEK to withstand harsh process environments.

| Comparison of Turbidity Measurement Technologies

Choosing the right sensor requires matching the technology to the process conditions. The following table outlines the primary differences:

Feature	Nephelometric (90°)	Absorption (180°)	Backscatter
Measurement Range	0 – 40 NTU (Highly sensitive)	40 – 4,000 NTU	1,000 – 100,000+ mg/L
Primary Application	Potable water, filtered effluent	Raw water, industrial process	Sludge, thickeners, tailings
Standard Compliance	ISO 7027 / EPA 180.1	General industrial	Process specific
Sensitivity to Color	Moderate (if using white light)	High	Low
Key Limitation	Saturated by high solids	Inaccurate at low levels	Requires high particle density

| Installation and Engineering Considerations

Proper installation is vital for the accuracy of a turbidity sensor. Unlike level meters, which can often be mounted with more flexibility, turbidity sensors are highly sensitive to the fluid dynamics of the installation point.

| Avoiding Entrained Air

Air bubbles are the primary enemy of accurate turbidity measurement. To a sensor, a bubble looks exactly like a solid particle, leading to false high readings. In pressurized pipelines, bubbles may be less common, but in open channels or gravity-fed lines, a bubble trap or a de-aeration chamber is often required before the sensor.

| Flow Rate and Orientation

For flow-through sensors, the velocity must be high enough to prevent particles from settling on the sensor optics but low enough to avoid cavitation. A typical flow rate range is 200 ml/min to 500 ml/min for bypass systems. For immersion sensors, the probe should be oriented so that the optical window faces the flow, allowing the moving liquid to naturally "scrub" the surface.

| Ambient Light Interference

Since these sensors rely on light detection, external light (especially sunlight in open-tank applications) can interfere with the readings. Sensors should be installed in shaded areas or within opaque flow cells to ensure the detector only sees the light from the internal source.

| Limitations and Maintenance

While turbidity sensors are powerful tools, they have inherent limitations that engineers must manage through regular maintenance.

1. Window Fouling: Over time, biofilms, mineral scales, or oils can coat the optical windows. This "fouling" attenuates the light and creates a drift in the measurement. Many industrial sensors now feature integrated mechanical wipers or ultrasonic cleaning systems to mitigate this.

2. **Particle Size and Shape:** Turbidity is a measure of light scattering, which is influenced by the size, shape, and refractive index of the particles. Two samples with the same mass of solids but different particle sizes will yield different NTU readings. This is why turbidity is often used as a proxy for Total Suspended Solids (TSS) only after site-specific calibration.

3. **Calibration Requirements:** Sensors must be calibrated using standardized Formazin solutions. Formazin is the only recognized primary standard for turbidity. Regular verification ensures that the sensor's light source hasn't dimmed and the detectors remain linear.

| Applications in Process Industries

Turbidity sensors are deployed across various sectors to automate quality control and protect downstream equipment.

Water and Wastewater Treatment: Monitoring the efficiency of sedimentation basins and the performance of sand filters. High turbidity in the effluent often indicates a filter breakthrough.

Chemical Processing: Monitoring the clarity of intermediate products or detecting the presence of precipitates in a reaction.

Food and Beverage: In Clean-in-Place (CIP) systems, turbidity sensors detect the interface between product and rinse water, reducing product loss and water consumption.

Industrial Automation: Protecting sensitive equipment like RO (Reverse Osmosis) membranes by ensuring the feed water meets strict clarity specifications.

As a professional manufacturer of industrial level measurement instruments, Welk understands that integrating turbidity data with level and flow measurements provides a complete picture of process health. For more information on comprehensive measurement solutions, you can visit the [Main Page](#).

| Frequently Asked Questions (FAQ)

Q: What is the difference between NTU and FNU?

A: NTU (Nephelometric Turbidity Units) is typically used when measuring with a white light source (EPA 180.1), while FNU (Formazin Nephelometric Units) is used when measuring with an Infrared light source (ISO 7027). Technically, they are equivalent if calibrated with Formazin, but the unit indicates the methodology used.

Q: Can a turbidity sensor measure Total Suspended Solids (TSS)?

A: Yes, but only through correlation. You must take lab samples of the liquid to determine the actual TSS (in mg/L) and then create a curve against the sensor's NTU output. This correlation is only valid as long as the particle characteristics (color, size, shape) remain consistent.

Q: How often should a turbidity sensor be calibrated?

A: In critical drinking water applications, monthly verification is common. In industrial wastewater, a quarterly calibration may suffice, provided the sensor has an automatic cleaning mechanism to prevent fouling.

Q: Does the color of the liquid affect the reading?

A: If using a white light sensor, yes. Darker liquids will absorb more light, potentially leading to errors. Using an Infrared (IR) sensor significantly reduces interference from dissolved colors (like tannins), which is why IR is the standard for most industrial B2B applications.

| Conclusion

Selecting a turbidity sensor is a process of matching optical geometry and light source technology to the specific characteristics of the process fluid. By understanding the principles of nephelometry and absorption, and by accounting for installation challenges like air bubbles and fouling, engineers can implement reliable monitoring systems. For those seeking high-quality industrial instrumentation and customized OEM/ODM services, reviewing the product range on the Main Page can provide the necessary technical foundation for your next project.