



Applied Microbiology
&
Biotechnology Laboratory

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Standard Operating Procedure

AMBL-106-A

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Turbidity by Nephelometric Determination

METHOD SUMMARY

This SOP describes the procedure for measuring turbidity in a water sample. This method is based on Method 2130 B (Standard Methods, 2017) and Method 180.1 (US EPA, 1993).

ENVIRONMENTAL HEALTH AND SAFETY

Hazards Assessment: This method will occasionally involve the use of a formazin suspension (turbidity standard) containing residual amounts of hydrazine sulfate. The specific hazards associated with this method are as follows.

Skin Contact: Formazin may cause an allergic reaction, rash or irritation.

Cancer: Hydrazine sulfate is a known carcinogen; formazin may cause cancer.

Environment: Harmful to aquatic life, having long-term, persistent effects on the environment.

Safety Equipment and Engineering Controls: When using a prepared formazin suspension, this method requires that an eye wash station and a shower be located nearby.

Personal Protective Equipment (PPE): This method requires the use of the following PPE.

Gloves (nitrile, PVC or neoprene)

Safety goggles or glasses

Laboratory coat

Analysis-derived Wastes and Disposal:

Waste Generated	Hazardous (Y / N)	Disposal
This procedure generates a waste that is simply original sample.	N	Unless a specific hazard is associated with the sample, original samples may be disposed in the sink.
This procedure will occasionally generate formazin suspensions that are no longer usable.	Y	Formazin suspensions must be disposed as a hazardous wastes. Do not release to the environment or allow to enter a sewer by pouring down a drain.

METHOD DESCRIPTION**1.0 Introduction and Applicability**

Turbidity is a measure of water clarity that is caused by suspended colloidal material that can include a variety of inorganic solid matter such as clay and silt, or dispersed organic particles that can include bacteria and other microorganisms. The measurement of turbidity is based on the light-scattering properties of a colloidal suspension, which scatters light at right-angles to the incoming or incident light. This scattered light will increase as the number of turbidity-causing colloidal particles increase. Measurement of turbidity is made using a nephelometer and turbidity readings are reported in nephelometric turbidity units, NTUs.

This method is particularly applicable for measuring turbidity of various raw waters used to supply drinking water, waters associated with the drinking water treatment processes, water in public water supply systems and in wastewaters reclaimed for reuse. Although this method can be used for other waters having minimal suspended material, its overall applicability in most waters having dissolved or color-causing substances that absorb light is limited.

2.0 Apparatus

- Nephelometer or turbidimeter, equipped with a tungsten-filament lamp (2200 – 3000°K color temperature), having a total light path length less than 10 cm, having a detector centered at 90 ± 30 degrees to the incident light and a peak response occurring between 400 and 600 nm.
- Sample cells, matched and without scratches or imperfections, thoroughly cleaned and without fingerprints or smudges.

3.0 Reagents

- a. Secondary turbidity standards, commercially available sealed suspensions or polymer-type standards provided by the instrument manufacturer.
- b. Primary turbidity standard, stock 4000 NTU formazin suspension used to verify and adjust commercial secondary standards that have aged and changed value.
- c. Turbidity-free dilution water, prepared from distilled water filtered through a 0.1 m membrane filter. Ensure the filtration flask or container used to contain the filtered water has been scrupulously washed with laboratory soap, rinsed multiple times with distilled water and air dried.

4.0 Procedure

- a. Read Method 2130 Turbidity (*Standard Methods*).
- b. Calibrate or verify the calibration of the instrument used. Read and follow the instrument manufacturer's instructions. If necessary, prepare a calibration curve.
- c. Turbidity of a sample should be determined as soon as possible after it is collected.
- d. Ensure that the sample is agitated well enough to provide a uniform and representative suspension, but without creating air bubbles. Pour sample into the sample cell and again, make sure there are no air bubbles. If necessary use a sonic bath to dislodge air bubbles from the glass walls of the sample cell by immersing the sample cell into the bath for 1 or 2 seconds.
- e. Use a soft, lint-free cloth to dry, if necessary, and clean dust or smudges from the outside of the sample cell. Optionally, apply a thin film of silicone oil to the glass on the outside of the sample cell to mask minor imperfections in the glass.
- f. Follow the instrument manufacturer's instructions for using the instrument, gently invert the sample cell two or three times to ensure the suspension is uniform, insert the sample cell and read turbidity from the instrument's display.
- g. Dilute samples having turbidities >40 NTU with turbidity-free water to achieve readings <40 NTU.
- h. Thoroughly rinse the sample from the sample cell using distilled or deionized water immediately after the reading is obtained and the sample cell is removed from the instrument. Allow the sample cell to air dry on a clean drying pad, or if used before dry, rinse the sample cell out with a volume of the new sample to be measured.

5.0 Calculation and Reporting

- a. Calculate original turbidity from samples diluted to achieve readings <40 NTU by correcting the turbidity reading using the dilution factor.

$$\text{Original Turbidity, NTU} = \frac{T}{D}$$

where T = turbidity reading, NTU, and

D = dilution factor (for example 1/5, 1/10, etc.).

- b. Report turbidity readings, as NTU, according to the following table.

Turbidity Range NTU	Report to Nearest NTU
0 – 1.0	0.05
1 – 10	0.1
10 -40	1
40 - 100	5
100 - 400	10
400 – 1000	50
>1000	100

6.0 Quality Control

Use of proper measurement technique is important for minimizing errors or interferences that reduce measurement accuracy and precision. Additionally, the quality of the turbidity-free reagent water used when preparing primary turbidity standards is important for low-level turbidity. Thus quality control is considered to be an important part of this method.

- a. Establish or verify the linearity of the calibration range every six months or more frequent if turbidity measurements are not routinely made. Establishing the linearity must use a minimum of one blank and five primary standards. Verifying linearity must use a minimum of one blank and three primary standards. If any linearity verification values exceed initial linearity values by more than $\pm 10\%$, reestablish a new initial linearity.
- b. At least annually, determine the method detection limit for each instrument used to measure turbidity.

- c. Measure one quality control sample (QCS) at least every three months or each time turbidity measurements are conducted if this is period is greater than three months. Use control charting to establish acceptance criteria, and if these criteria are exceeded, investigate the reason and take necessary corrective action.
- d. Measure turbidity of at least one laboratory reagent blank (LRB, turbidity-free water) at the beginning and end of every ten samples, and at the end of the sample run. Subtract the LRB value from any turbidity reading on a sample diluted to <40 NTU.
- e. Measure one mid-range calibration check standard (CCS) after every 10 or fewer samples. If the difference between the CCS true value and the reading or the values determined from a calibration curve is greater than $\pm 10\%$, recalibrate the instrument.
- f. Analyze at least one sample in duplicate with each batch of 20 or fewer samples. If a single sample is being analyzed, this sample must be analyzed in duplicate. The relative percent difference (RPD) of duplicate samples should not exceed an absolute value of 5%.

7.0 Bibliography

- 1. Rodger B. Baird, Andrew D. Eaton, and Eugene W. Rice (2017) *Standard Methods for the Examination of Water and Wastewater*. APHA, Washington, DC, 23rd Edition.
- 2. U.S. Environmental Protection Agency (1993) Method 180.1 Determination of Turbidity by Nephelometry, ORD Environmental Monitoring Systems Laboratory, Cincinnati, Ohio.