

DETERMINATION OF TURBIDITY BY NEPHELOMETRY

Hach Method 8195

Revision 3.0

March 2018

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1.0 SCOPE AND APPLICATION

- 1.1 This method covers the determination of turbidity from colorless, membrane filtered drinking water, conventional filtered drinking water, ground water, surface water, and treated wastewater that has a turbidity of less than or equal to 40 NTU.
- 1.2 This method may be used for compliance monitoring under the Safe Drinking Water Act (SDWA) 40 CFR 141, the USEPA Long-term Treatment Rule, LT1/LT2, The Clean Water Act (CWA) 40 CFR 136, and California Code of Regulations, Title 22.

2.0 SUMMARY OF METHOD

- 2.1 The method is based upon a comparison of the intensity of light scattered by the sample under defined conditions with the intensity of light scattered by a standard reference suspension. The higher the intensity of the scattered light, the higher the turbidity. Measurements in NTU are made with a nephelometer designed according to specifications outlined in Section 6 of this method. A primary standard suspension of Formazin or stabilized Formazin is used to verify the analytical system's on-going accuracy and stability of measurement (Section 9).

3.0 DEFINITIONS

- 3.1 MATERIAL SAFETY DATA SHEET – Written information provided by vendors concerning a chemical/s toxicity, health hazards, physical properties, fire, and reactivity data including storage, spill, and handling precautions.
- 3.2 LINEAR CALIBRATION RANGE - The turbidity range over which the instrument response is linear.
- 3.3 PRIMARY CALIBRATION STANDARD - A Formazin suspension prepared from the primary dilution stock standard suspension or StablCal bulk solution or prefilled all glass flame-sealed vials. The suspension solutions are used to calibrate the instrument response with respect to turbidity. The suspension may be in a bulk form that is transferred to the open sample measuring vial or a StablCal pre-filled all glass, flamed-sealed vial.
- 3.4 QUALITY CONTROL SAMPLE – A Formazin suspension prepared from a source that is different from the primary prepared standards. This may be from an alternate preparation of the stock standard suspension or an alternate lot of a commercial preparation primary standard such as StablCal either in bulk solution or prefilled all glass flame-sealed vials.

- 3.5 SECONDARY CALIBRATION VERIFICATION STANDARD– A manufacturer supplied or user prepared standard for checking instrument performance between required calibrations. An example is a gel standard calibrated by the user to the turbidity of a primary standard.
- 3.6 STOCK STANDARD SUSPENSION - Concentrated Formazin solution (40 NTU) that is used to prepare diluted primary calibration and calibration verification standards.

4.0 INTERFERENCES

- 4.1 The presence of floating debris and coarse sediments which settle out rapidly will yield low NTU measurements. Finely divided air bubbles may also cause elevated NTU measurements
- 4.2 The presence of true color (e.g., humic substances) will cause turbidity readings to be low, although this effect is generally not significant in finished treated drinking water and treated wastewater final effluent.
- 4.3 Light-absorbing materials such as activated carbon in significant amounts may interfere with turbidity readings.

5.0 SAFETY

- 5.1 The toxicity or carcinogenicity of each reagent used in executing this method has not been fully established. Each chemical should be regarded as a potential health hazard and exposure should be as low as reasonably achievable.
- 5.2 Each field and laboratory facility is responsible for maintaining a current awareness file of OSHA regulations regarding the safe handling of the chemicals specified in this method. A reference file of MSDS documents should be made available to all personnel involved in the chemical analysis. A formal safety plan should also be made available.
- 5.3 Hydrazine sulfate is highly toxic and may be fatal if inhaled, swallowed or absorbed through the skin. Formazin can contain residual hydrazine sulfate. Proper protection should be employed.

6.0 EQUIPMENT

- 6.1 Turbidimeter – Hach 2100 series and TL23 series nephelometers that employ a tungsten light or LED source in Section 6.2 or Section 6.3.
- 6.1.1 Hach Automatic Cleaning Module (Recommended for water matrices containing high levels of iron or manganese, or in wastewater applications).
- 6.1.2 Vials are to be kept scrupulously clean, both inside and out, and discarded when they become scratched or etched.

6.2 Tungsten Optics

- 6.2.1 Light source - Tungsten lamp operated at a color temperature between 2200-3000°K.
- 6.6.2 Distance traversed by incident and scattered light within sample vessel – Total distance not to exceed 10 cm.
- 6.6.3 Detector – Centered at 90° to the incident light path and not to exceed $\pm 30^\circ$ from 90°. The detector and optional filter system shall have a spectral peak response between 400 and 600 nm.

6.3 LED Optics

- 6.3.1 Light Source - An LED operated such that the full width at half maximum (FWHM) is in the range of 830 to 890 nm.
 - 6.3.1.1 Tungsten lamps fitted with monochromators and filters, diodes, and lasers may be used as a source of monochromatic radiation.
 - 6.3.2 There shall be no divergence from parallelism at the incident radiation and any convergence shall not exceed 1.5°.
 - 6.3.3 Total distance traversed by incident light and scattered light within the sample vessel shall not exceed 10 cm.
 - 6.3.4 Detector – Centered at 90° to the incident light path and not to exceed $\pm 2.5^\circ$ from 90°. The detector and optional filter system shall have a spectral peak response between 860 ± 30 nm.
- 6.4 Sample vials must be of clear, colorless glass or plastic. They should be kept scrupulously clean, both inside and out, and discarded when they become scratched or etched. A light coating of silicon oil may be used to mask minor imperfections in glass vials.
- 6.5 Balance – Analytical, capable of accurately weighing to the nearest 0.0001 g.
- 6.6 Glassware – Class A volumetric flasks and pipets as required for making Formazin preparations and sample dilutions.

7.0 REAGENTS AND STANDARDS

- 7.1 Reagent water for sample dilutions and facility prepared Formazin calibration standards, turbidity-free to less than 0.03 NTU.

- 7.2 StablCal Primary Calibration Standard bulk or StablCal filled flamed-sealed glass vial Suspensions
- 7.3 User Prepared Stock Standard Suspension (Formazin only).
- 7.3.1 Dissolve 1.00 g hydrazine sulfate, $(\text{NH}_2)_2\text{H}_2\text{SO}_4$, (CAS 10034-93-2) in reagent water and dilute to 100 mL in a volumetric flask. CAUTION -- carcinogen.
- 7.3.2 Stock Standard Suspension - Dissolve 10.00 g hexamethylenetetramine (CAS 100-97-0) in reagent water and dilute to 100 mL in a volumetric flask.
- 7.3.3 Intermediate Suspension - In a 100-mL volumetric flask, add 5.0 mL of each stock solution in 10.5.1 and 10.5.2. Allow to stand 24 hours at $25 \pm 3^\circ\text{C}$, then dilute to the mark with reagent water.
- 7.3.3.1 Primary Calibration Formazin Standards - Mix and dilute 10.0 mL of the Intermediate Suspension (10.5.3) to 100 mL with reagent water. The turbidity of this suspension is defined as 40 NTU. For other values, mix and dilute portions of this suspension as required.
- 7.3.3.2 A new intermediate suspension should be prepared each month. Primary calibration standards should be prepared daily by dilution of the stock standard suspension.

8.0 GRAB SAMPLES FOR PRESERVATION, DILUTION AND ANALYSIS

- 8.1 Samples should be analyzed as soon as possible after collection.
- 8.2 Collect each sample in a soft or hard plastic or glass container. Immediately refrigerate or ice the sample to 4°C and analyze within 48 hours of collection.
- 8.3 Prolonged time to analysis of grab samples may yield different turbidity results than in-line samples, as turbidity in water is unstable.

9.0 QUALITY CONTROL

- 9.1 Each facility using this method for regulated environmental monitoring is required to operate a formal quality assurance/control program. The minimum initial requirements of this program consist of the demonstration of the facility's capability with this method by analyzing Linear Calibration Range and Quality Control turbidity standards.
- 9.1.1 Linear Calibration Range

9.1.1.1 Verify the analytical system's linearity (light source, sample vial, and detector) using either StablCal bulk solution or prefilled StablCal all glass flame-sealed vial or Formazin Calibration Standard as described in Section 7. The calibration verification linearity test solution should be in the range of 10 NTU to 0.8 NTU. Lower level calibration standard solutions may be used if the accuracy can be established within 10% of its stated value.

9.1.2 Quality Control Sample

9.1.2.1 When beginning the use of this method, on a quarterly basis, or as required complying with data-quality needs, verify the calibration and acceptable instrument performance, with the preparation and analysis of a quality control sample as defined in Section 3.4. If the measured turbidities are not within $\pm 10\%$ of the stated values, performance of the determinative step of the method is unacceptable. The source of the problem must be identified and corrected before continuing with on-going analyses.

10.0 CALIBRATION AND CALIBRATION VERIFICATION STANDARDIZATION

10.1 Calibration

10.1.1 Calibrate the instrument with bulk Formazin suspension, StablCal or StablCal filled all-glass flame-sealed vials following the manufacturer's operating instructions.

10.2 Calibration Verification

10.2.1 The calibration verification standard should be in the range of 10 NTU to 0.8 NTU. Lower level calibration standards may be used if their accuracy can be independently established within 10% of its stated value.

10.2.2 The measured value of the standard shall be within 10% of its stated value. If the measured value greater than 10%, repeat the test with a new standard and clean test vial, or a new sealed calibration vial.

10.2.3 If upon following step in 10.2.2 the calibration verification continues to fail, perform a new calibration as described in Section 10.1.1 and verify calibration as in Section 10.2.2.

11.0 TURBIDITY MEASUREMENT PROCEDURE

11.1 Follow the manufacturer's instructions for the proper set up and operation of the instrument.

11.1.1 Turbidities exceeding 40 NTU: Dilute the sample with one of more volumes of distilled water or membrane filtered water until the turbidity falls below 40 NTU. The turbidity of the original sample is then computed from the turbidity of the diluted sample and the dilution factor. For example, if 5 volumes of 0.2 μm filtered distilled water were added to 1 volume of sample, and the diluted sample showed a turbidity of 30 NTU, then the

turbidity of the original is calculated to be 180 NTU. Samples requiring dilution shall be analyzed using static flow conditions.

11.2 Calibration and Calibration Verification Frequency

11.2.1 Calibration - When beginning the use of this method and on a quarterly basis or as required to comply with regulatory requirements and data-quality needs

11.2.2 Calibration Verification - Dependent on the conditions of the sample vial (biofilm, scratches in the wall surface) and the less likely change in light source and detector stability. Recommendation is to verify calibration on a weekly basis.

12.0 CALCULATIONS

12.1 No analyst calculations are required for undiluted sample analysis as the processor has a built-in sample calculator.

12.2 Matrix Sample Dilution Calculation – An additional calculation is required for diluted samples.

12.2.1 Dilution Formula:

$$T = Ax$$

where:

T = Final calculated NTU turbidity result

A = NTU result from diluted sample

$x = (B + C) / C$ = Dilution factor

B = volume of dilution water, in mL

C = sample volume taken for dilution, in mL

12.3 Example of Dilution Calculation:

Measurement from diluted sample (A) – 0.035 NTU

Sample volume to be diluted (C) – 10 mL

Volume of dilution water (B) – 990 mL

Dilution factor (x) = $(990 + 10) / 10 = 100$

Final Turbidity (T) = 0.035 NTU x 100 = 3.500 NTU

13.0 DATA REPORTING

13.1 The recommended rounding of data for regulatory reporting purposes is presented in the following table:

NTU Range	Record to Nearest Value
To 1.0	0.05
1 -10	0.1
10 - 40	1
40 – 100	5
100 – 400	10
400 - 1000	50
> 1000	100

14.0 METHOD PERFORMANCE

14.1 In a single laboratory using surface water samples at levels of 26, 41, 75, and 180 NTU, the standard deviations were ± 0.60 , 0.94, 1.2, and 4.7 NTU, respectively.

15.0 POLLUTION CONTROL

15.1 Pollution prevention encompasses any technique that reduces or eliminates the quantity or toxicity of waste at the point of generation. Numerous opportunities for pollution prevention exist in laboratory operation. The EPA has established a preferred hierarchy of environmental management techniques that places pollution prevention as the management option of first choice. Whenever feasible, laboratory personnel should use pollution prevention techniques to address their waste generation. When wastes cannot be feasibly reduced at the source, the Agency recommends recycling as the next best option.

15.2 The quantity of chemicals purchased should be based on expected usage during its shelf life and disposal cost of unused material. Actual reagent preparation volumes should reflect anticipated usage and reagent stability.

16.0 WASTE MANAGEMENT

16.1 The U.S. Environmental Protection Agency requires that laboratory waste management practices be conducted consistent with all applicable rules and regulations. Excess reagents, samples and method process wastes should be characterized and disposed of in an acceptable manner. The Agency urges laboratories to protect the air, water and land by minimizing and controlling all releases from hoods, and bench operations, complying with the letter and spirit of any waste discharge permit and regulations, and by complying with all solid and hazardous waste regulations, particularly the hazardous waste identification rules and land disposal restrictions. For further information on waste management consult the "Waste Management Manual for Laboratory Personnel," available from the American Chemical Society at the address listed in Section 15.3.

17.0 References

1. Annual Book of ASTM Standards, Volume 11.01 Water (1), Standard D1889-88A, p. 359, (1993).
2. Standard Methods for the Examination of Water and Wastewater, 18th Edition, pp. 2-9, Method 2130B, (1992).
3. Standard Methods for the Certification of Laboratories Analyzing Drinking Water: Criteria and Procedures, Quality Assurance, EPA/570/9-90/008, April,1990.
4. Hach Method 10258, Determination of Turbidity by Laser Nephelometry, Hach Company, 5600 Lindbergh Drive, Loveland, Colorado 80538.
5. Guidance Manual for Compliance with the Interim Enhanced Surface Water Treatment Rule: Turbidity Provisions, United States Environmental Protection agency, Office of Water (4607), EPA 815-R-99-010, April 1999.
6. California Code of Regulations, Title 22.