Thermo Scientific Orion AQUAfast AQ3010 Turbidity Meter

User Guide

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This publication supersedes all previous publications on this subject.

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Chapter 1 Introduction

General Information

This user guide contains information on the preparation, operation and maintenance of the Thermo Scientific Orion AQUAfast® AQ3010 turbidity meter. This user guide provides both a step by step guide to help you operate the waterproof AQ3010 turbidity meter and serves as a handy reference guide.

Follow the basic instructions contained in this user guide during the operation, care and maintenance of the meter. The safety protections provided by this equipment may be impaired if it is used in a manner not described in this user guide. It is recommended that all operators should read this user guide prior to working with this meter.

The manufacturer will not accept any responsibility for damage or malfunction to the meter caused by improper use of the instrument.

The information presented in this user guide is subject to change without notice as improvements are made, and does not represent a commitment on the part of the manufacturer.

Note: The manufacturer reserves the right to make improvements in design, construction and appearance of products without notice.

AQ3010 Meter Overview

Thank you for selecting the waterproof portable AQ3010 turbidity meter. The AQ3010 meter allows you to measure turbidity of an aqueous sample in the field. This instrument operates on the nephelometric principle of turbidity measurement and is designed to meet the criteria specified in ISO 7027 and DIN 27027 standards. See the **Measurement Principle** section.

Unpacking the Meter and Accessories

The list below indicates the items that you should find in your AQ3010 turbidity meter shipment.

Item	Quantity
AQ3010 portable turbidity meter with 4 AAA batteries	1
User guide	1
Instrument carrying case	1
Light shield cover	1
Calibration set with 0.02, 20.0,100 and 800 NTU standards	1
Empty calibration vials	4
Empty sample vials	3
Silicone oil	1
Lint free cloth	1
Vial cleaning brush	1

Remove the AQ3010 turbidity meter from the carrying case. Carefully inspect all items to ensure that no visible damage has occurred during shipment. If the items you received do not match your order, please contact your dealer immediately.

Warning: Extra care should be taken when unpacking, opening and handling the calibration standards and sample vials. Surface scratches or finger smudges on the vial surface may cause measurement errors. Handle these items by their caps only.

The batteries provided with the meter package are to be installed prior to use. Refer to the **Battery Installation** section.

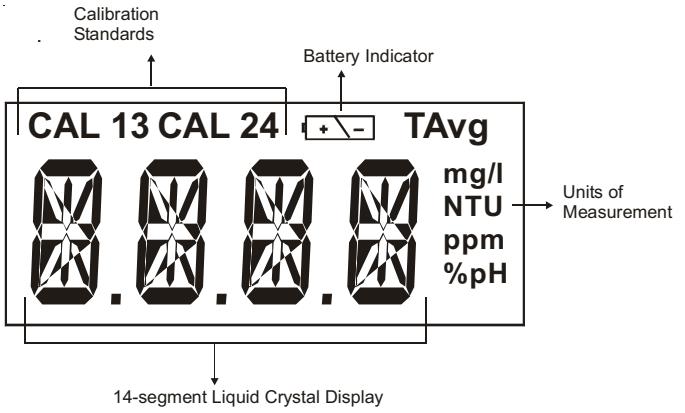
Figure 1 shows the meter. The three main components of the instrument are the sample well, the display and the keypad. The following sections describe the functionality of the display and the keypad. The proper use of the instrument and the sample well are discussed in later sections.

Figure 1
AQ3010 Turbidity Meter Components

Display

All the LCD segments and annunciators that can appear on the display are shown in **Figure 2**. The display is used for reporting the turbidity reading and to provide guidance for the operation of the instrument. In addition, the display has several other annunciators that are used to communicate error messages and provide user guidance.

Figure 2
Customized LCD with All Annunciators



Keys and Functions

The keypad has five keys: **ON/OFF**, **CAL**, ▲, ▼ and **READ/ENTER**.

Key	Functions
⏻	Powers on and off the meter. The meter automatically shuts off 20 minutes after last key press to conserve the battery life.
CAL	Initiates the calibration mode of the meter. When pressed, the meter is set to accept the first calibration standard. It is also used to exit the calibration mode if the user does not want to follow the complete calibration procedure.
READ / ENTER	When in measurement mode, the **READ/ENTER** key is used to perform a measurement. Single-shot measurements: When the key is pressed and released immediately (a quick key stroke of less than 0.3 seconds), the display will blink [-Rd-] ten times and display the measured value. Continuous measurements: If the **READ/ENTER** key is pressed and held, the instrument will perform a continuous measurement during which the display is updated every 2 seconds. This can be used for indexing vials. (This function is not available in calibration mode). After the **READ/ENTER** key is released, the instrument will automatically perform a single-shot measurement.
▲ ▼	Active only during calibration mode. These scroll keys are used to select the next calibration point. Note: After the successful calibration of one point, the meter automatically selects the next calibration point, or automatically exits the calibration mode after the fourth calibration point.

Figure 3 Keypad

Battery Installation

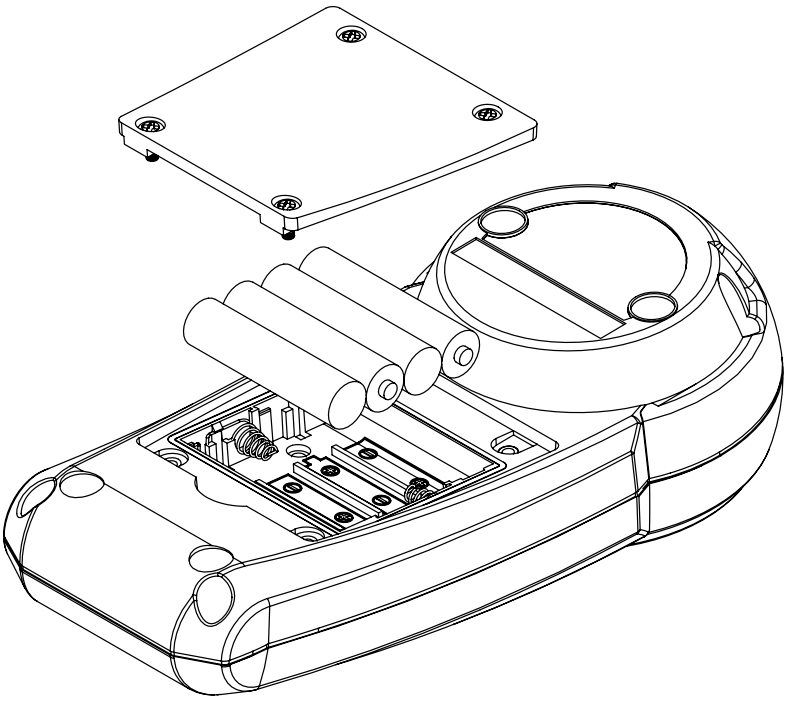
Four AAA batteries are included in the carrying case.

Note: Use caution when loosening the screws, as some of the screws may be tightly seated.

1. Use a Phillips screwdriver to loosen the four screws holding the battery cover. See **Figure 4**. These captive screws will remain attached to the battery cover.
2. Remove the battery cover.
3. Insert the batteries. Follow the diagram inside the cover for correct polarity.
4. Replace the battery cover in its original position and tighten the four screws removed earlier to secure the battery cover to the meter.
5. The meter is now ready for use.

Note: Dispose of used batteries in accordance with your local regulations.

Figure 4
Battery Installation



Chapter 2 Turbidity Calibration

Calibration Overview

The AQ3010 turbidity meter was calibrated and tested prior to leaving the factory. The meter kit includes a set of prepared primary standards that can be used to verify the meter calibration daily and to recalibrate the meter, if required. Before measuring samples for the first time, verify the meter calibration with the prepared primary standards.

The SDVB primary standards in the meter kit are in plastic bottles for improved precision and shelf life. Four vials are included and labeled for each standard level.

The instrument includes a light shield cover to keep stray light from changing the calibration and sample measurement readings. In many environments, the light shield is not required. The vial cap keeps stray light from entering the sample well, saving you many steps and reducing analysis time.

Indexing

Due to the high quality of the glass vials provided, indexing is not required. You only need to align the mark on the vial with the mark on the meter. However, in order to achieve a better precision of the measurement, you can proceed with indexing of the vials. See the **Indexing a Vial** section for more information.

Calibration Standards

We recommend that you use the following materials during calibration to achieve the precision stated in this user guide:

- CAL 1: 800 NTU calibration standard
- CAL 2: 100 NTU calibration standard
- CAL 3: 20.0 NTU calibration standard
- CAL 4: 0.02 NTU calibration standard

It is well known that diluted Formazin is unstable. If you choose to use Formazin to calibrate the instrument, ensure that you are using a fresh stock suspension of Formazin to achieve the precision quoted for the instrument. It is very difficult to accurately pipet Formazin for low level NTU standards, due to the non-homogeneous nature of Formazin and because these standards have very limited stability at low levels. Be sure to use good laboratory technique and accurate Class A pipets and refer to ASTM Method 6855-03 for low level standard vial preparation when using Formazin.

The four bottles of calibration standards supplied with your meter are more stable than Formazin, do not need to be shaken and have a shelf life of 12 months. If you use the supplied calibration standards to calibrate the instrument, review the expiration date (indicated on the bottle label) to ensure that the standards have not expired.

Note: It is important that the calibration standards are not violently shaken or agitated because air entrapment in the fluid introduces an error factor during calibration which subsequently will lead to an inaccurate measurement. Also, do not store in freezing temperatures which causes irreversible shrinkage of the standards' particles thus resulting to inaccurate calibration and measurement.

Preparing and Filling the Calibration Standard Vials

Before using the meter for the first time, rinse the inside of the vial with a small amount of the same NTU standard that will be used to fill that vial.

1. Gently pour about 5 mL of the standard into the vial.
2. Cap and swirl the vial so the inside of the vial is fully rinsed with the standard.
3. Pour the standard out of the vial.
4. Repeat steps 1 through 3.
5. Gently pour the standard into the vial up to the mark on the vial and cap the vial.
6. Repeat this rinse and filling procedure for the other three vials.

Note: The vial rinsing is most critical for precision with the lower NTU standards.

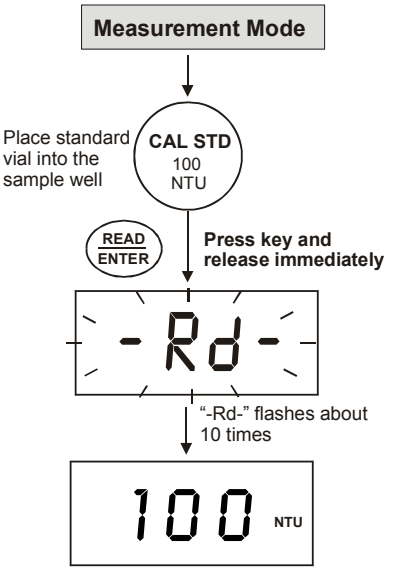
It is recommended to use the prepared calibration standard vials daily as check standards prior to the measurement of samples.

Calibration Check

1. Place the AQ3010 turbidity meter on a flat and level surface.
2. Insert the CAL 1 standard (800 NTU) into the sample well, aligning the mark on the vial with the alignment mark on the meter. See **Figure 11**.
3. Press down the vial until it slides fully into the instrument.
4. Cover the vial using the light shield cover, if necessary. For many environments this is not required. The vial cap seals the sample well.
5. Press the **ON/OFF** key to turn on the meter. The meter goes to measurement mode after the self test power-up sequence.
6. Press the **READ/ENTER** key.
7. The meter will display the results. Record the reading.
8. Repeat the calibration check for CAL 2, CAL 3 and CAL 4 calibration standards.
9. If the displayed results are within 10% of the nominal NTU value of the standard or the precision criteria required by your method, the calibration check passed and the meter is now ready for measurement.

Note: If a standard no longer reads within 10% of the nominal NTU value for the standard, the standard has most likely degraded. The lower level NTU standards will be less stable when stored in glass than the higher NTU standards. The lower level standards may need to be replaced periodically, especially if the value falls outside of the tolerance range. See the **Refilling the Calibration Standard Vials with Fresh Standard** section.

Figure 5
Calibration Check Sequence



Refilling the Calibration Standard Vials with Fresh Standard

1. Pour the old standard out of the vial.
2. Wash the vial with laboratory glassware detergent and water. Rinse the vial with turbidity-free water to remove all laboratory detergent from the vial.
3. Rinse the vial with about 5 mL of the standard from the plastic bottle with the matching NTU value.
4. Cap and swirl the vial so the inside of the vial is fully rinsed with the fresh standard.
5. Pour the standard out of the vial.
6. Pour the fresh standard into the vial up to the mark on the vial and cap the vial.
7. Perform the procedure in the **Calibration Check** section with the vial containing the fresh standard.

If the fresh standard does not read with the 10% range of the nominal value, or to the tolerance of your method, follow the steps in the **Calibration Procedure** section.

Calibration Procedure

Note: Before switching on the AQ3010 turbidity meter, a sample vial must be placed in the sample well. You can use any of the calibration standards for this purpose. If a sample vial is not placed in the sample well, the turbidity meter will display the Err 8 error message. To clear the error message, power off the meter., insert a sample vial into the sample well and power on the meter.

1. Place the AQ3010 turbidity meter on a flat and level surface.

2. Press the **ON/OFF** key to turn on the meter. The meter goes to measurement mode after the self test power-up sequence.

3. Select the calibration function of the instrument by pressing the **CAL** key once. The "CAL" annunciator will blink momentarily and the meter will prompt for the first calibration standard by displaying "CAL 1 800 NTU".

4. Insert the CAL 1 standard (800 NTU) into the sample well, aligning the mark on the vial with the alignment mark on the meter. See **Figure 11**.

5. Press down the vial until it slides fully into the instrument.

6. Cover the vial using the light shield cover, if necessary. For many environments this is not required. The vial cap seals the sample well.

7. Press the **READ/ENTER** key.

8. The "CAL 1 800 NTU" annunciator will blink for about 12 seconds while the instrument performs the calibration of CAL 1 point. When the instrument has completed calibration for this point, it will prompt you to insert the next calibration standard into the sample well by displaying "CAL 2 100 NTU".

9. Repeat steps 4 through 8 for the CAL 2, CAL 3 and CAL 4 calibration standards.

10. After you successfully calibrate the CAL 4 standard (0.02 NTU), the meter will display "STbY".

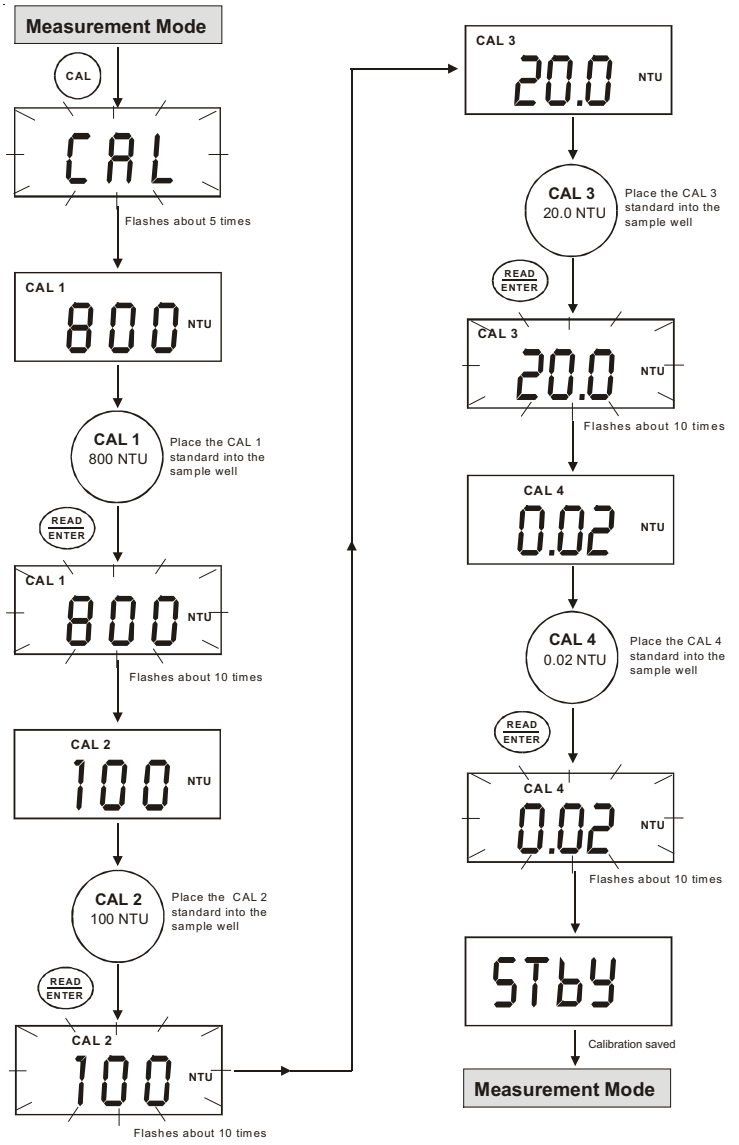
11. The meter is now ready for measurement.

Figure 6 shows the complete calibration sequence.

Calibration Notes

- To exit the calibration mode, press the **CAL** key at the end of any step. The meter accepts only the values calibrated prior to exiting.
- You can skip a calibration point by pressing the ▲ or ▼ key and move on to the next calibration point.
- After a successful calibration of one point, the meter automatically selects the next calibration point. The meter automatically exits calibration mode after the fourth calibration point.
- If an error occurs during calibration, the display shows an error message. The meter aborts the calibration and returns to the measurement mode without saving the last calibration value.
- For an error list, refer to the **Troubleshooting Guide** section.

Figure 6 Calibration Sequence



Restoring Factory Calibration

The AQ3010 turbidity meter allows you to reset the meter back to the factory default calibration values. This feature is extremely useful when there are errors in calibration or when you have new calibration standards.

1. With the meter switched off, press and hold the ▲ key.

2. Switch on the meter by pressing the **ON/OFF** key. Release the ▲ key when "URST" (User-Reset) appears on the display.

3. The display will show "URST" for about 2 seconds and then "No".

4. Use the ▲ or ▼ key to scroll between "YES" or "No".

    - YES = Restore the meter back to factory calibration values

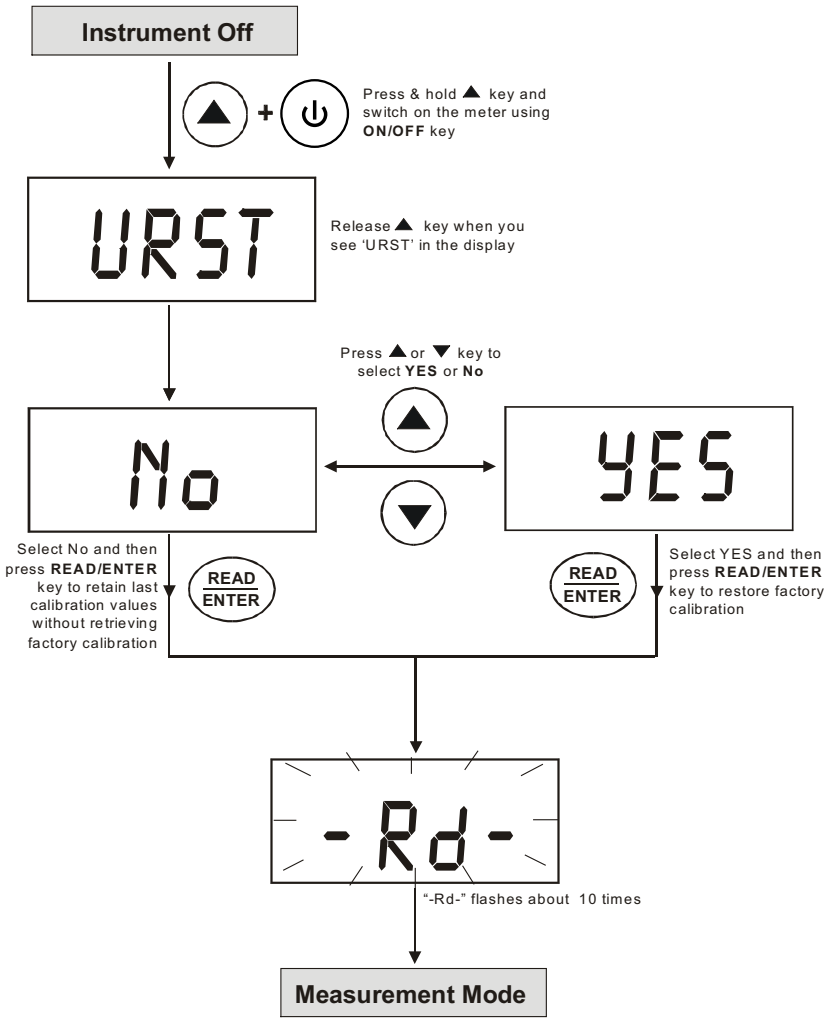
    - No = Retain the last calibrated values

5. Press the **READ/ENTER** key to confirm your selection. The meter performs the reset if "YES" is selected.

6. The display will flash "-Rd-" about ten times and the meter will go to the measurement mode.

Figure 7 shows the sequence for restoring factory calibration values.

Figure 7
Restoring Factory Calibration



Chapter 3 Turbidity Measurement

General Information

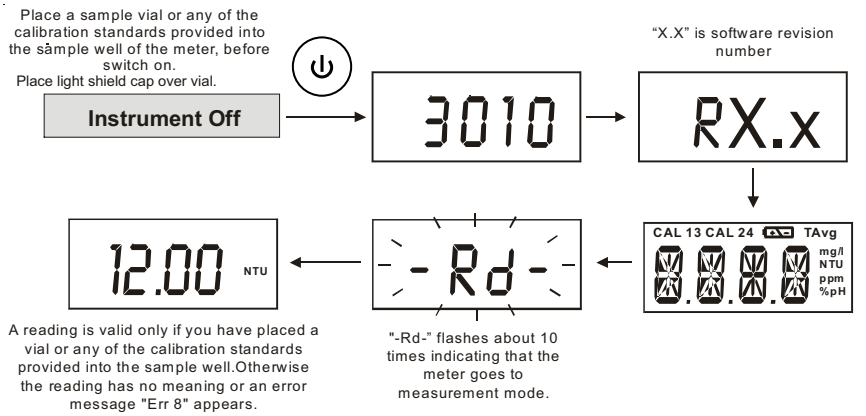
The AQ3010 waterproof turbidity meter allows you to measure the turbidity of a grab sample. The turbidity is reported in Nephelometric Turbidity Units (NTU). Readings above 1000 NTU are outside the range of this instrument.

Note: Before switching on the AQ3010 turbidity meter, a sample vial must be placed in the sample well. You can use any of the calibration standards for this purpose.

The instrument includes a light shield cover to keep stray light from changing the calibration and sample measurement readings. In many environments, the light shield is not required. The vial cap keeps stray light from entering the sample well, saving you many steps and reducing analysis time.

When the **ON/OFF** key is pressed to switch on the meter, it goes through the power-up sequence as shown in **Figure 8**.

Figure 8
Power-up Sequence



Turbidity Measurement Procedure

An accurate turbidity measurement depends on good measurement techniques. Factors such as clean sample vials, positioning of vial in the sample well, covering the vial with the light shield cover (if needed), meter calibration, handling of meter and others have to be taken into consideration. Refer to the **Vials – Handling, Cleaning and Care** and **Appendix 2 Guide to Good Measurement Technique** sections for more information.

Preparation of Sample Vial

1. Obtain a clean and dry sample vial. See **Figure 9**. Take care to handle the sample vial by the top cap.

2. Rinse the vial with approximately 10 mL of the sample water, capping the vial with the black screw cap and gently inverting it several times. Discard the used sample and repeat the rinsing procedure two times.

4. Fill the rinsed vial with the remaining portion (approximately 10 mL) of the grab sample up to the mark indicated in the vial. Cap the vial with the supplied black screw cap.

5. Wipe the vial with the soft, lint-free cloth supplied. Ensure that the outside of the vial is dry, clean and free from smudges.

6. Apply a thin film of silicone oil (supplied) on the sample vial. See **Figure 10**.

7. Wipe the vial with a soft cloth to obtain an even distribution over the entire vial surface. The purpose of oiling the vial is to fill small scratches and to mask the imperfection in the glass. Do not apply large quantity of oil as this may collect dirt and dust.

8. The sample vial is now ready to be inserted into the sample well of the meter for measurement.

Figure 9
Sample Vial

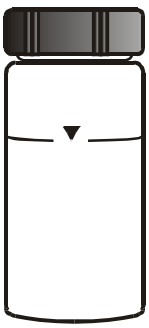
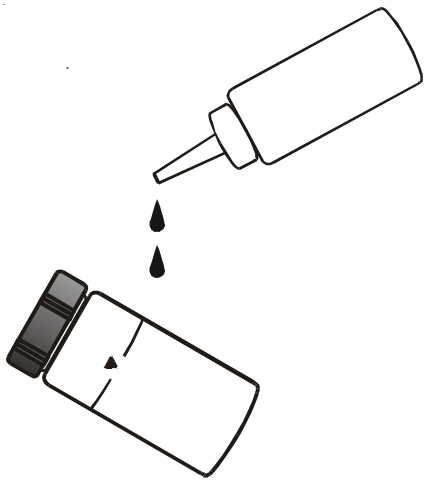


Figure 10
Applying the Silicon Oil



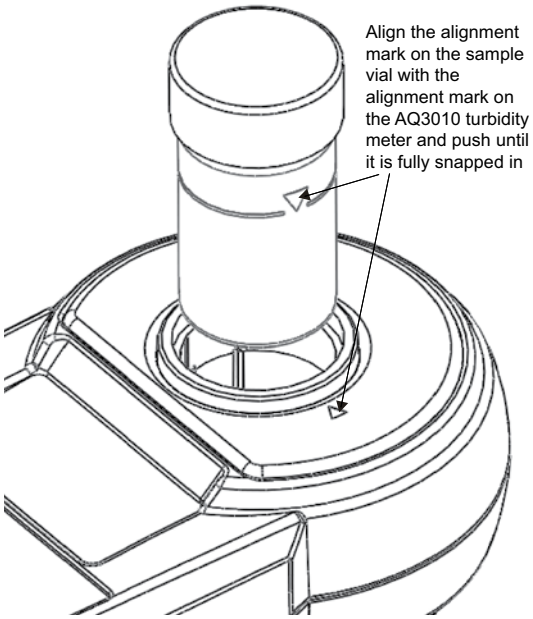
Measurement Procedure

1. Place the AQ3010 turbidity meter on a flat and level surface.

Note: Do not hold the meter in your hand while operating it, as this may cause inaccurate measurements.

2. Place the sample vial inside the sample well and align the vial's alignment mark with the meter's alignment mark. See **Figure 11**.

Figure 11
Aligning the Sample Vial Alignment Mark with the Meter Alignment Mark



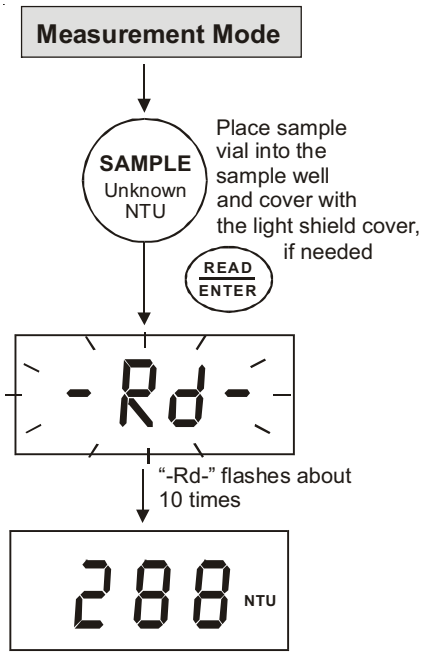
3. Push the vial down until it slides fully in.

4. Cover the vial using the light shield cover, if necessary. For many environments this is not required. The vial cap seals the sample well.

5. Turn on the meter by pressing the **ON/OFF** key.

6. After the power-up sequence, the meter will go to the measurement mode and the display will blink "-Rd-" about ten times. See **Figure 12**.

Figure 12 Reading a Turbidity Value



7. The measured reading will appear in the display.

8. If necessary, place the second sample vial into the sample well. Align the vial alignment mark with the meter alignment mark.

9. Press the **READ/ENTER** key. The display will blink "-Rd-" several times and measured reading will appear.

10. Repeat this procedure for all of your samples.

Measurement Notes

- **Never pour liquid directly into the sample well of the instrument**. Always use a 25 mm vial. The instrument will only accurately measure the turbidity of a sample when 25 mm vials sealed with the black caps are used. The black cap serves to both seal the vial and block stray light.

- Never attempt to clean the sample well. The optics may be damaged.

- For battery conservation, the instrument automatically powers off 20 minutes after the last key pressed.

Single-Shot or Continuous Measurement

You can use the AQ3010 turbidity meter to take a single reading or perform continuous measurement. The latter is only used for indexing the vials. See the **Indexing a Vial** section for more information.

For Single-Shot Measurement

1. Make sure the meter is sitting on a flat and level surface and is in measurement mode. The display will show the last measured value or "STbY" after exiting calibration mode.

2. Place the sample vial in the sample well.

3. Cover the vial using the light shield cover, if necessary. For many environments this is not required. The vial cap seals the sample well.

4. Press the **READ/ENTER** key and immediately release it (less than 0.3 seconds). See **Figure 13**.

5. The display will blink "-Rd-" about ten times and then display the measured value.

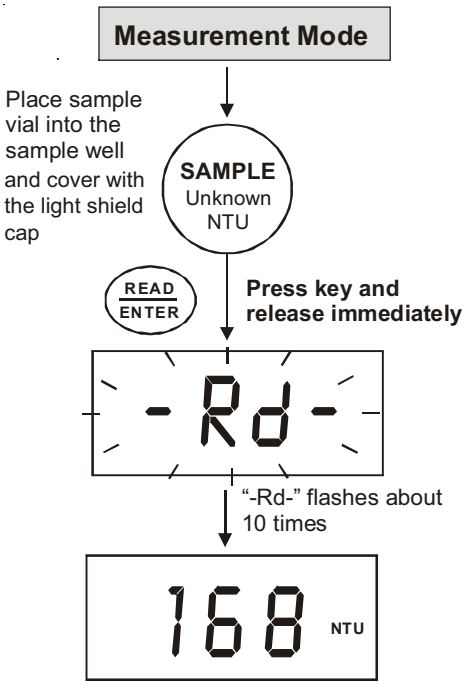


Figure 13 Single-Shot Measurement

For Continuous Measurement

1. Make sure the meter is sitting on a flat and level surface and is in the measurement mode. The display will show the last measured value or "STbY".

2. Place the sample vial in the sample well.

3. Cover the vial using the light shield cover, if necessary. For many environments this is not required. The vial cap seals the sample well.

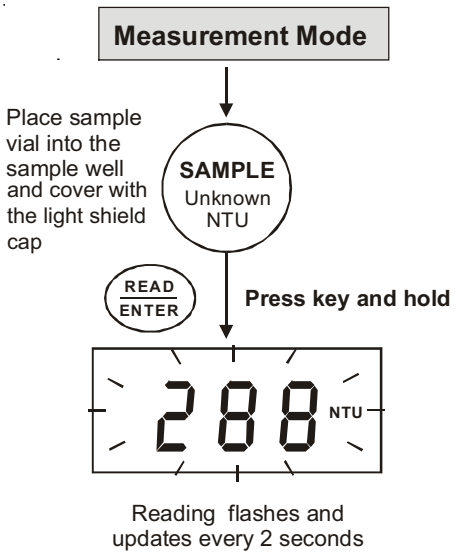
4. Press the **READ/ENTER** key and hold it. See **Figure 14**.

5. Wait for the reading to stabilize before rotating the sample vial. You can rotate the sample vial for indexing purpose. See the **Indexing a Vial** section for more information.

   Note: During continuous measurement, the display is updated every 2 seconds. The displayed reading may not be the actual turbidity value. For accurate measurement, use the single-shot measurement.

6. Once you release the **READ/ENTER** key, the meter automatically performs a single-shot measurement.

Figure 14 Continuous Measurement



Continuous Measurement Notes

- After a measurement is completed and the display is updated, a 4 second recovery time occurs before the meter can perform another function. If any key is pressed during this time, the meter will perform the corresponding action at the end of the recovery period.

- When performing a measurement, if the meter detects stray light exceeding the amount equivalent to 0.02 NTU in the low range, the measurement is immediately aborted and an error message [ERR 8] is displayed. Ensure that the vial sits properly into the sample well and the light shield cover is on. Press the ENTER/READ key to retake the measurement.

Chapter 4 Routine Maintenance

The supplied carrying case is optimal for protecting the instrument. If you do not plan on leaving the instrument in the supplied carrying case, when it not in use ensure that the instrument has been turned off and that a clean sample vial fitted with a black cap has been placed in the sample well. This will ensure that a minimal amount of dust and debris will be able to settle on the optics of the instrument. Keep the light shield cover with the meter.

Vials – Handling, Cleaning and Care

Proper measurement of the turbidity of a sample requires the use of a vial that is free of marks, smudges, scratches and any bacterial growth. Therefore, sample vials must be handled with absolute care to avoid contamination or damage, which might change the optical characteristics of the glass. Scratches, fingerprints and water droplets on the sample vial or inside the sample well can cause stray light interference leading to inaccurate readings.

Cleaning the vial is accomplished by washing the interior and exterior of the vial in a detergent solution. Once cleaned, the vial should be rinsed thoroughly eight to ten times with clean distilled or deionized water to eliminate the possibility of detergent buildup and streaking.

Vials can also be acid washed periodically and coated with a special silicone oil to fill small scratches and mask the imperfections in the glass. Since the silicone oil required for this application should have the same refractive characteristics as glass, it is recommended that only the Thermo Scientific Orion AQUAfast® silicone oil, Cat. No. AC3SIL, be used. Care should be taken not to apply excessive oil that could attract dirt or contaminate the sample well of the meter. Once the oil has been applied to the vial, the excess oil should be removed with a lint-free cloth. The result should be a sample vial surface with a dry appearance, but with all imperfections filled with oil.

Sample vials should always be handled from the top or by the cap to avoid fingerprints or smudges. After a vial has been filled with a sample and capped, the outside surface should be wiped with a clean, lint-free absorbent cloth until it is dry. Cleaned and dried vials should be stored with the black caps on. The vials can be stored in the carrying case. During normal operation, you may use any typical laboratory glass cleaner along with a lint free cloth or tissue to clean the outside of the vials.

Condensation may appear on the vial when your sample is very cold and the relative air humidity is high. When this happens, the turbidity that you read may be higher than the actual turbidity due to the light scattered by the condensate on the vial. If this occurs, you can alleviate the problem by either coating the vial with an anti-fogging agent or by running warm water over the vial for a short period of time to warm the sample prior to measurement.

Chapter 5 Customer Services

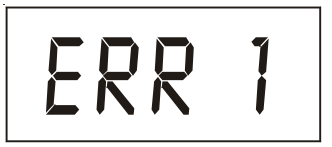
Troubleshooting Guide

The AQ3010 turbidity meter routinely performs self-diagnostics and will automatically generate messages to provide you with specific diagnostic information. These messages are for your use and do not indicate a reduction in the performance of the instrument or a failure of any component in the instrument, unless otherwise stated in this list.

LCD Message	Description	Corrective Actions
ERR 1	Calibration error – the meter is unable to recognize the 800 NTU calibration standard.	Use the correct 800 NTU calibration standard. Pour fresh standard into a clean vial and retry the calibration. Verify that the standard has not expired.
ERR 2	Calibration error – the meter is unable to recognize the 100 NTU calibration standard.	Use the correct 100 NTU calibration standard. Pour fresh standard into a clean vial and retry the calibration. Verify that the standard has not expired.
ERR 3	Calibration error – the meter is unable to recognize the 20.0 NTU calibration standard.	Use the correct 20.0 NTU calibration standard. Pour fresh standard into a clean vial and retry the calibration. Verify that the standard has not expired.
ERR 4	Calibration error – the meter is unable to recognize the 0.02 NTU calibration standard.	Use the correct 0.02 NTU calibration standard. Pour fresh standard into a clean vial and retry the calibration. Verify that the standard has not expired.
ERR 5	Calibration error – there is not sufficient signal to achieve the appropriate resolution in the 0 to 1000 NTU range.	Pour fresh standard into a clean vial and retry the calibration with all four standards. Verify that the standards have not expired.
ERR 6	General calibration failure – there is not sufficient signal to achieve the appropriate resolution in the 0 to 100 NTU range.	Pour fresh standard into a clean vial and retry the calibration with all four standards. Verify that the standards have not expired.
ERR 7	General calibration failure – there is not sufficient signal to achieve the appropriate resolution in the 0 to 20 NTU range.	Pour fresh standard into a clean vial and retry the calibration with all four standards. Verify that the standards have not expired.

LCD Message	Description	Corrective Actions
ERR 8	Excessive stray light detected.	Verify that the vial is fully in the sample well and light shield cover is properly placed over the vial.
	Attempting a measurement when low battery indicator is on.	Replace the batteries.
ERR 9	Lamp failure.	Contact Technical Support.
Or	Turbidity value is above the measurement range (>1000 NTU).	Dilute sample, see the **Dilution** section.
	Low battery indication – the batteries need to be replaced.	Replace the batteries.

Note: If an error message appears, take the appropriate corrective action and re-do the desired procedure. If the problem persists, contact Technical Support or your dealer.



Assistance

After troubleshooting all components of your measurement system, contact Technical Support. Within the United States call 1.800.225.1480 and outside the United States call 978.232.6000 or fax 978.232.6031. In Europe, the Middle East and Africa, contact your local authorized dealer. For the most current contact information, visit www.thermo.com/contactwater.

Warranty

For the most current warranty information, visit www.thermo.com/water.

The AQ3010 meter is supplied with a 3 year warranty from manufacturing defects and calibration standards for 6 months. If repair or adjustment is necessary and has not been the result of abuse or misuse within the designated period, please contact Technical Support or your dealer for an RMT number. A repair technician will determine if the product problem is due to deviations or customer misuse. Out of warranty products will be repaired on a charged basis.

Exclusions

The instrument warranty shall not apply to defects resulting from:

- Improper or inadequate maintenance by customer
- Unauthorized modification or misuse
- Operation outside of the environment specifications of the products

Waterproof Seal: Opening the instrument enclosure (excluding the battery compartment) may void the warranty.

Notice of Compliance

Warning: This meter may radiate radio frequency energy and if not installed and used properly, that is in strict accordance with the manufacturer's instructions, may cause interference to radio communications. It has been tested and found to comply with the limits for a Class A computing device pursuant to Subpart J of Part 15 of FCC Rules, which are designed to provide reasonable protection against such interference in a commercial environment. Operation of the meter in a residential area may cause interference in which case the user at his own expense will be required to take whatever measures may be required to correct the interference.

The Thermo Scientific Orion AQ3010 turbidity meter is CE and cTUVus certified, which includes TUV 3-in-1 testing to EMC and US and Canadian standards.

WEEE Compliance

This product is required to comply with the European Union's Waste Electrical and Electronic Equipment (WEEE) Directive 2002/96/EC. It is marked with the following symbol:

We have contracted with one or more recycling/disposal companies in each EU Member State and this product should be disposed of or recycled through them. Further information on compliance with these Directives, the recyclers in your country, and information on Thermo Scientific Orion products which may assist the detection of substances subject to the RoHS Directive are available at www.thermo.com/WEEERoHS.

Declaration of Conformity

Manufacturer: Thermo Fisher Scientific Inc.
166 Cummings Center
Beverly, MA 01915 USA

The manufacturer hereby declares that the AQ3010 turbidity meter conforms with the following standards and documents:

Safety EN/IEC 61010-1:2001

EMC EC 89/336/EEC Electromagnetic Compatibility
EN 61326-1:2006

Emissions EN 61326-1:2006 Emissions
CISPR 11:2003 Radiated Emissions
FCC Part 15B Class A

Immunity EN 61326-1:2006 Immunity
IEC 61000-4-2:2001 Electrostatic Discharge Immunity
IEC 61000-4-3:2002 RF Radiated Immunity

This Thermo Scientific Orion product has been manufactured in compliance with the provisions of the relevant manufacturing and test documents and processes. These documents and processes are recognized as complying with ISO 9001:2008 by QMI, listed as File # 001911.

Patrick Chiu
Senior Quality Engineer,
Regulatory Compliance

June 3, 2009
Beverly, MA

Ordering Information

Cat. No.	Description
AQ3010	AQ3010 waterproof portable turbidity meter with set of 4 calibration standards (800, 100, 20.0 and 0.02 NTU) in plastic bottles, set of 4 calibration vials, set of 3 sample vials, lint-free cloth, silicone oil, vial cleaning brush, batteries and rugged carrying case
AC301S	Replacement calibration standards kit, includes 800, 100, 20.0 and 0.02 NTU standards in plastic bottles
AC3V25	Replacement sample vials, pack of 3, 25 mm diameter
AC3SIL	Silicone oil, 10 mL bottle, and lint-free cloth
AC3CBR	Replacement vial cleaning brush

Specifications

Parameter	Specification
Measurement Method	ISO 7027 compliant nephelometric method (90°)
Measurement Range	0 to 1000 NTU
Automatic Range Selection	0.01 to 19.99 NTU 20.0 to 99.9 NTU 100 to 1000 NTU
Resolution	0.01 NTU (0 to 19.99 NTU) 0.1 NTU (20 to 99.9 NTU) 1 NTU (100 to 1000 NTU)
Precision	±2% of reading ± 1 LSD for 0 to 500 NTU; ±3% of reading ± 1 LSD for 501 to 1000 NTU
Calibration Standards	0.02 NTU, 20 NTU, 100 NTU, 800 NTU
Standardization	EPA approved polymer-based primary standards
Light Source	Infrared-emitting diode (850 nm wavelength)
Light Source Life	> 1,000,000 tests
Detector	Silicon photovoltaic
Stray Light	< 0.02 NTU
Display	4 digit 14 segments customized liquid crystal display with annunciators
Sample Vials (Cuvettes)	Glass vials with screw caps, fill line and indexing mark, 51 (H) x 25 (Dia) mm (2 x 1 in)
Sample Volume Required	10 mL (0.33 oz)
Operating Temperature Range	0 °C to 50 °C (32 °F to 122 °F)
Sample Temperature Range	0 °C to 50 °C (32 °F to 122 °F)
Operating Humidity Range	0 to 90% relative humidity, non-condensing at 30 °C (86 °F)
Power Supply	4 x AAA alkaline batteries
Battery Life	> 1200 readings
Enclosure Type	ABS plastic
Waterproof Rating:	IP67
Regulatory Certification	CE, cTUVus, TUV 3-in-1, FCC part 15
Insulation Rating	Pollution Degree 2
Weight:	Meter: 0.23 kg (0.51 lb) Meter with case: 2.0 kg (4.4 lb)
Dimensions	Meter: 7.9 (W) x 17.2 (L) x 5.0 (H) cm (3.1 x 6.8 x 2.0 in) Meter & case: 35 (W) x 27 (L) x 15 (H) cm (13.8 x 10.6 x 5.9 in)

Appendix 1 Turbidity Theory

Definition

Turbidity is defined as an "expression of the optical property that causes light to be scattered and absorbed rather than transmitted in straight lines through the sample." That is, turbidity is the measure of relative sample clarity, not color.

Water with cloudy or opaque appearance will have high turbidity, while water that is clear or translucent will have low turbidity. High turbidity value is caused by particles such as silt, clay, microorganisms and organic matter. By definition, turbidity is not a direct measure of these particles but rather a measure of how these particles scatter light.

Why Is It Important?

For drinking water applications, a turbidity value may give an indication of presence of bacteria, pathogens or particles that can shelter harmful organisms from disinfection process. Therefore, turbidity measurement is particularly useful for water treatment plants to ensure cleanliness. For wastewater effluent testing, turbidity is often required to ensure that the released effluent will not harm the environment.

In industrial processes, turbidity can be part of quality control measure to ensure efficiency in treatment or manufacturing process.

Measurement Principle

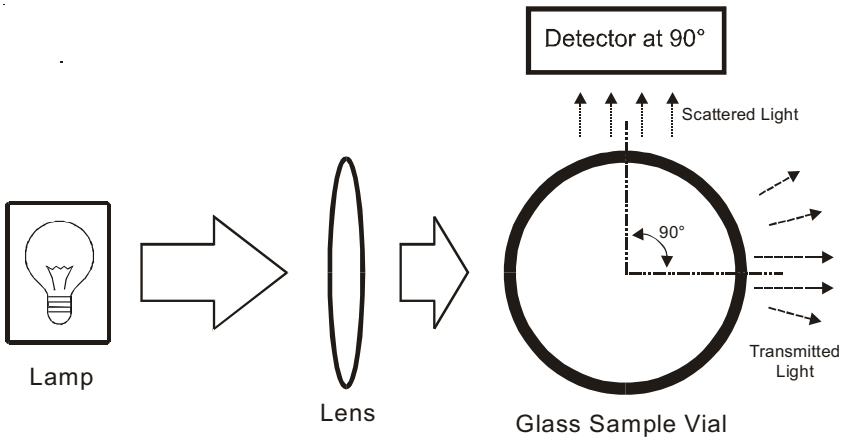
There are two internationally accepted standard specifications for turbidity measurement. These are the international standard ISO 7027 and the US EPA method 180.1.

Basically the ISO 7027 is a more stringent standard and requires the use of a monochromatic light source. It also governs the design of a turbidity meter in the following areas: (1) Light source's wavelength; (2) Light sources' spectral bandwidth; (3) Measuring angle; (4) Aperture angle in water sample; (5) Distance traversed by incident light and scattered light within the sample and (6) Calibration standard.

The AQ3010 turbidity meter follows the ISO 7027 standard whose specification allows for greater reproducibility of the measured values and greater agreement between other measuring instruments.

Figure 15 shows the AQ3010 waterproof turbidity meter basic optical system. It includes a light source and a detector to monitor the light scattered at 90° with respect to the incident beam.

Figure 15 Basic Nephelometric Arrangement for Turbidity Measurement



Nephelometric Turbidity Units (NTU)

Nephelometric Turbidity Units (NTU): Unit of measure used when relating the light scattered by a liquid media to the light scattered by a known concentration of a standard solution. This unit of measure is recognized as a measure of the optical clarity of an aqueous sample. NTU is the accepted unit of measurement for turbidity.

Another unit commonly used to measure turbidity is Formazin Turbidity Unit (FTU). The two units of measure of turbidity are equivalent: 1 NTU = 1 FTU.

Indexing a Vial

The United States Environmental Protection Agency (US EPA) recommends that vials used for turbidity meter calibration or sample measurement be indexed.

To index a sample vial, slowly rotate the vial throughout one complete revolution (360°). While rotating the sample vial, observe the display and locate the position that the vial is in which provides the lowest turbidity reading. This position is the indexed position of the vial.

Mark this position on the vial (not on the cap) against the mark on the meter.

After indexing a vial, make sure the vial will always be placed inside the sample well in the indexed position.

Appendix 2 Guide to Good Measurement Technique

Turbidity is a very complex analytical measurement that can be affected by many factors. Some are inherent in the instrument's design such as angle of detection, light beam aperture, incident beam wavelength and color sensitivity of the photocell.

However, there are other factors such as stray light, air bubbles and care of vial, which can be prevented through proper care of equipment and accessories, and in the operating procedure for measurement. Here are some points you may want to note.

Maintain Sample Vials in Good Condition

Sample vials must be meticulously clean and free from significant scratches. It should be treated on the outside with a thin coat of silicone oil. This is to mask minor imperfections and scratches that may contribute to stray light. Sample vials should be handled only by the top to avoid dirt accumulation (or deposits) and fingerprints that might interfere with the light path.

More information can be found in the **Vials – Handling, Cleaning and Care** section.

Match Sample Vials

Best precision and repeatability of turbidity measurement are achieved using a single, indexed vial. However, for more convenience, different vials can be used for measurement provided their readings with the same solution are matched. That is, the meter gives identical readings or within the specified repeatability and precision of the meter.

Select a few vials. After the sample vials are cleaned, fill them with ultra-low turbidity water. Allow the sample vials to stand and for air bubbles to rise. Polish sample vials with silicone oil and take turbidity measurement at several points while rotating it in the sample well. Find the position where turbidity reading is the lowest and index it for each vial. Whenever these sample vials are used, use the indexed mark to position each vial into the sample well. Choose those vials that match the readings.

Note: Not all vials can be matched due to some manufacturing variations.

Degassing

Air or other trapped gases should be removed before measurement. Degassing is recommended even if no bubbles are visible. There are three methods commonly used for degassing:

- Addition of a surfactant: This involves adding a surfactant to the water samples to lower the surface tension of the water, thereby releasing trapped gasses.
- Application of a partial vacuum: A partial vacuum can be created by using simple syringe or vacuum pump. This is only recommended for ultra-low turbidity measurements.
- Use of an ultrasonic bath: This may be effective in severe conditions or in viscous samples, but not recommended for ultra-low measurements.

Each of the method above has its own advantages and disadvantages. For instance, under certain sample conditions, the use of vacuum pump or ultrasonic bath may actually increase the presence of gas bubbles.

Timeliness of Sample Measurement

Samples should be measured immediately to prevent changes in particle characteristics due to temperature and settling. Temperature can affect particles by changing their behavior or creating new particles if precipitates are formed. Dilution water may dissolve particles or change their characteristics. It is recommended to take samples only when the turbidity meter is ready to be operated. Samples should not be drawn and allowed to sit while the instrument warms up or is being readied.

Other Important Sampling Techniques

1. Samples should not be violently shaken or agitated as particles can be broken apart or air may be entrapped into the fluid. Gentle agitation such as swirling the sample vial is advisable to reduce particle settling.
2. Sample vials should be used only with the instruments for which they were intended. Do not mix and match vials. The AQ3010 uses 25 mm sample vials.
3. Perform a visual observation of the sample vial every time a measurement is made. Ensure that there are no visible bubbles in the sample and the vial is clean and free of scratches.
4. Samples entering the turbidity meter should be at the same temperature as the process flow samples. Changes in temperature can cause precipitation of soluble compounds and affect readings.
5. Sample vials should be evaluated with a low turbidity water (after cleaning) to determine if cells remain matched. If the evaluation determines that a cell is corrupted, discard the vial. It is recommended to conduct this evaluation weekly.
6. When in doubt about whether a sample vial is too scratched or stained, throw it away.

Calibration Techniques

1. Keep the calibration standard plastic bottles and vials tightly capped and ensure that they are not allowed to freeze.
2. Check that the standards have not expired.
3. Make sure that the calibration vials are free of dust, smudges and scratches before use.
4. Conduct the calibration in the same manner each time. Variations in how the calibration is performed could yield inaccurate measurements.
5. It is very important that the users who perform calibration have been trained to do so. Creating a Standard Operating Procedure (SOP) for the users to read, learn, and practice may help to ensure precision.

Dilution Techniques

This dilution procedure is necessary only when your turbidity measurement is above 1000 NTU.

1. To measure the turbidity above 1000 NTU, dilute the sample with turbidity-free water.

2. Turbidity-free water can be obtained by filtering deionized water through a < 0.2 µm filter membrane with precision-sized pores.

3. Measure the volume of the sample (V_s) before dilution and record the value in mL.

4. Take a known volume (V_d) of dilution water and add it to the sample.

5. Pour 10 mL of the diluted sample in a clean vial and measure the turbidity of the diluted sample. Record this value in NTU (T_d).

6. Calculate the true turbidity (T) of the original sample in NTU using the following formula:

   $T = T_d \bullet (V_s + V_d) / V_s$

Example:

- Dilute 20 mL of the original sample (with turbidity above 1000 NTU) with 50 mL of dilution water.

- Measure the turbidity of the diluted sample.

- If the reading is 300 NTU, the turbidity of the original sample is 1050 NTU.

- In this example Td = 300 NTU, Vs = 20 mL, Vd = 50 mL, so T = 300 • (20+50) / 20 = 300 • 70/20 = 21000/20 = 1050.

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