

EXTREME LIQUID ANALYSIS



pH/ORP SENSOR MANUAL

Contents

Safety Precautions	1
General.....	1
Qualification and Training of Personnel	1
Safe Operation	1
Installation, Maintenance and Inspection	2
Unauthorised Modification.....	2
Chemicals	2
Health and Safety.....	2
Environmental Considerations.....	2
Introduction	3
Specifications.....	4
Body Plastics	4
Reference Materials.....	4
Dimensions.....	4
Installation	6
Site Selection.....	6
Unpacking	6
Wiring.....	7
Calibration.....	8
pH Calibration - Buffer and Slope Adjustment	8
ORP Calibration	8
Troubleshooting	9
Raw mV Display	9
Common Thermal Related Issues	9
Common Offset Type Issues.....	9
pH Buffer Accuracy & Stability Issues	9
pH Buffer During Calibration	10
Temperature effects on pH Reading.....	10
Sensor Maintenance	10
Maintenance Free	10
Storage	10

Cleaning a Turtle Tough pH/ORP Sensor	11
Recommended Cleaning Schedule.....	11
Cleaning.....	11
Avoiding Thermal Shock.....	12
Conditioning for Calibration.....	12
Warranty Statement	12
Product Warranty	12
Sensor Warranty.....	13
Shelf Life Warranty	13
Performance Warranties	13
Life Expectancy Guarantee	13
Lowest Cost of Ownership.....	14
Blown Pre-Amplifiers	14
Return Goods.....	15
Support	15

Safety Precautions

DANGER

Disconnect electrical supply before working on this equipment.

- Before attempting to unpack, set up, or operate this instrument, please read this entire manual.
- Make certain the unit is disconnected from the power source before attempting to service or remove any component.
- Make certain the unit is disconnected from other sources of force or pressure (for example, pneumatic or hydraulic) before attempting to service or remove any component.
- Failure to follow these precautions could result in personal injury and damage to the equipment.

General

This manual contains basic information to be noted during installation, operation and maintenance. It is therefore essential that this manual be read by the contractor before installing and commissioning the pH/ORP Sensor, as well as by the relevant operating personnel/owner of the unit. It must remain available for reference at all times.

In addition to the general safety instructions under this main heading Safety Precautions, the special safety precautions outlined in other sections must also be observed.

Qualification and Training of Personnel

The personnel employed for installation, operation, inspection, and maintenance, must be suitably qualified for this work. The areas of responsibility, competence and supervision of the personnel must be precisely defined by the owner. Personnel who do not have the required know-how must be trained and instructed.

In addition, the owner of the system must ensure that the relevant personnel are fully familiar with and have understood the contents of this manual.

Should training be required please contact your Turtle Tough distributor.

Safe Operation

The safety instructions contained in this manual must be observed. The owner is responsible for ensuring compliance with local safety regulations.

Installation, Maintenance and Inspection

The owner must ensure that all maintenance, inspection and installation work is undertaken by authorised and duly qualified personnel who have also studied this manual.

- The pH/ORP Sensor must always be isolated before starting any work.
- Please be aware that the pH/ORP Sensor and the associated analyser may be controlling chemical dosing and as such shutting down the unit without due regard to the systems it is controlling can lead to chemical release.



Warning

Unauthorised Modification

Usage other than as described in this manual will lead to the immediate cancellation of the warranty and any other manufacturer's liability.



Caution

Chemicals

Should the pH/ORP sensor be in contact with hazardous chemicals, great care must be taken when handling the sensors.

CAUTION

When handling the sensor, the accident prevention regulations applicable on site must be observed and the specified personal protective equipment worn.



Appropriate PPE to be worn when in contact with the sensor.

PPE: examples of protective clothing, gloves and goggles.

IMPORTANT

Please unpack the equipment and ordered accessories carefully in order not to miss small parts. Immediately compare the scope of delivery to the delivery note. If there are any discrepancies, contact your local distributor.



Important

Health and Safety

Before making or breaking any electrical or signal connections, ensure that the instrument is isolated from the electrical supply.



Disconnect electrical supply before working on this equipment.

Environmental Considerations

Please use this product in a manner sensitive to the environment and at the end of its life dispose or recycle in a manner appropriate at that time that is in compliance with local regulations.



Take care when removing the sensor.

Introduction

Congratulations on purchasing a Turtle Tough sensor. Turtle Tough sensors are handmade with care and precision, combining state-of-the art technology and materials to deliver superior performance under extreme conditions. This instruction manual provides information for the correct installation and use of Turtle Tough pH/ORP sensors to ensure you get the maximum life and performance from your sensor.

All Turtle Tough pH/ORP sensors utilise a solid-state conductive reference junction. With this technology we are able to achieve accurate measurement while resisting process contamination into the reference system. This ability to maintain high ionic conductivity while resisting aggressive gas intrusion is what makes our sensors outlast virtually all others in any process conditions.

Your Turtle Tough sensor is built with our unique and proprietary glass formulations and sensing elements to provide extreme performance in harsh environments. Through our experience in the world's toughest applications we have developed sensors that have been optimised for high hydrofluoric acid, saturated sodium, high sulphide, organic solvents, high temperature and slurry/viscous applications. Our application specific sensors include industrial, Waste Water, Acid Etching, Nickel, Gold, Titanium Dioxide, Food & Beverage and Pharmaceutical. Please ensure that the model you are using is suitable for your intended application. You can locate your specific sensor in the sensor selection matrix, which can be found at <http://www.turtletough.com.au/support/sensor-selection-guides/>

pH/ORP Sensor Contents

All Turtle Tough instruments undergo a thorough quality control and calibration before delivery and always include a detailed instruction manual. Your pH/ORP Sensor includes the following items:

- pH/ORP sensor
- User's manual

Specifications

Turtle tough sensors are made from a variety of specialised plastics, references, sealants and materials.

For your sensor configuration please refer to our website (www.turtletough.com.au)

Please ensure the composition of your chosen pH/ORP sensor is appropriate for your application. To ensure your sensor is fully optimized it is recommended a Turtle Tough Application Questionnaire be completed which can be found at:

<http://www.turtletough.com.au/turtle-tough-extreme-liquid-analysis-application-questionnaire/>

Body Plastics

There are 4 main body plastics a Turtle Tough Sensor can be supplied in:

- CPVC - Chlorinated-Polyvinyl-Chloride
- RYTON - Poly-Phenylene-Sulfone
- RADEL - Poly-Phenyl-Sulfone
- PEEK - Poly-Ether-Ether-Ketone

Each body plastic serves a function based on accuracy, cost, chemical resistance and temperature resistance.

Reference Materials

The two types of reference materials available are:

- HDPE - High-Density Polyethylene
- KYNAR - Poly-Vinylidene-Fluoride

Each reference provides benefits around accuracy, cost, chemical/gas resistance and temperature resistance.

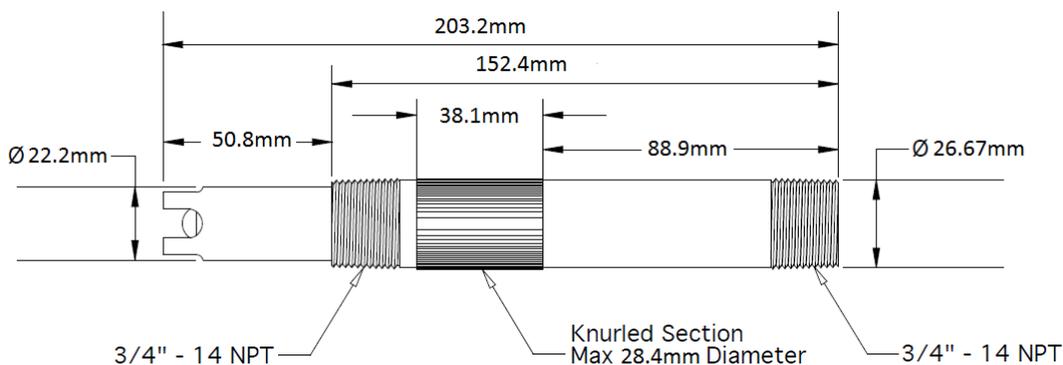
Dimensions

There are 4 main body styles of Turtle Tough Sensors:

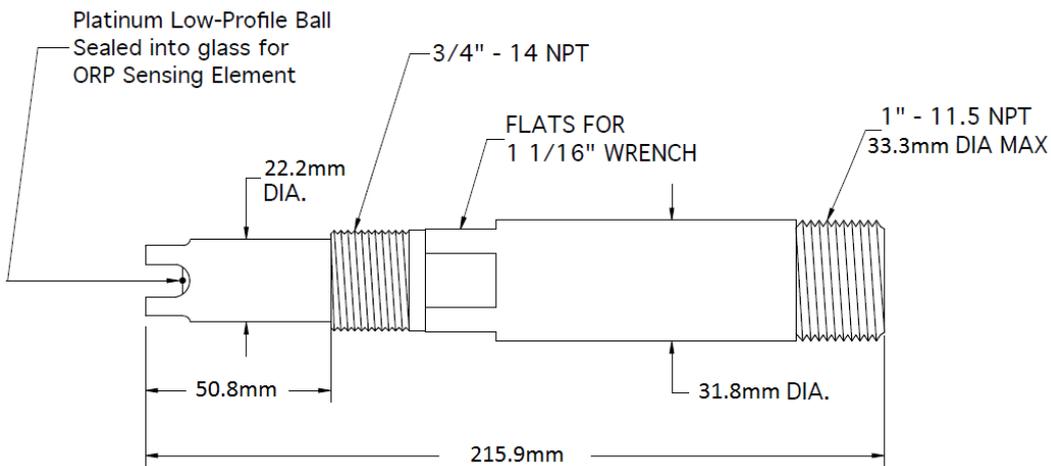
- 3/4"-3/4"
- 3/4"-1"
- Twistlock-1"
- 3/4" Sanitary

Dimensions for each style follow:

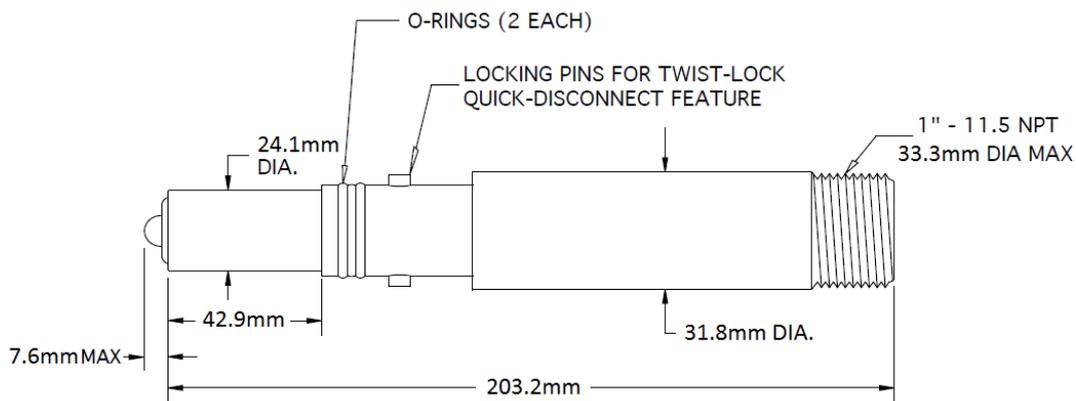
3/4"-3/4" Sensor (pH Sensor shown with optional guard and without waterproofing & cable)



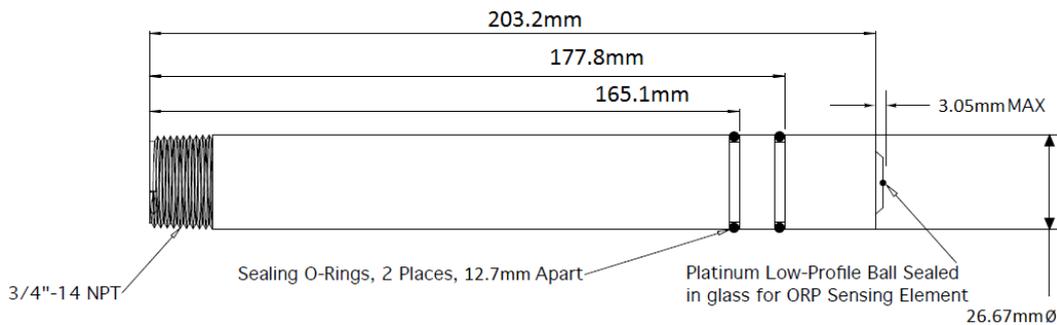
3/4"-1" Sensor (ORP Sensor shown with optional guard and without waterproofing & cable)



Twistlock-1" (pH Sensor shown without optional guard, waterproofing & cable)



Sanitary-3/4" (ORP Sensor shown without optional guard, waterproofing & cable)



Installation

As with all instrumentation the installation and commissioning of this sensor is crucial to its safe and effective operation. This sensor must only be used for its purpose as outlined in this manual. It must be installed and commissioned in accordance with this manual and by trained, qualified personnel.



Danger

Site Selection

Please choose a suitable location for the installation of the sensor. The choice of installation point on any site is a compromise and is best undertaken by an experienced installation engineer. The following is a list of the factors that need to be taken into consideration. This list is not intended as a check-list neither is it implied that the list is complete.



Electric Shock Hazard

- Ensure that the sensor is positioned to enable adequate flow
- Avoid installing the sensor within 1m of any dosing point
- Minimise all potential sources of electrical interference
- Static & Ground Loop Faults can damage the sensor or cause erroneous readings and all precautions should be taken to avoid them



Important

Unpacking

Please have a copy of your order with you when you unpack your instrument. All orders are checked when they leave the factory. Please check that you have all the parts that were ordered as soon as you open the box.



Important

If anything is missing, or damaged, please contact your sales outlet immediately. If the instrument needs to be returned for any reason please follow the return instructions given in this manual.

Please dispose of the packing in an environmentally responsible manner and in compliance with local regulations

Mounting

A Turtle Tough pH/ORP Sensor has been engineered for installation into industrial processes. Use within the specifications is highly recommended to obtain optimal sensor life.



Caution

Care should be taken to avoid any moisture ingress through the cable inlet/outlet.

pH Sensors are optimally installed at 45° as this avoids air bubbles being trapped at the sensor/process interface and ensures optimal glass/silver-chloride interaction. They should never be installed horizontally or inverted.

All pH/ORP sensors can be installed in-line. Submersible installation is also possible provided adequate waterproofing is selected at time of order or adequate sealing is made between the sensor and immersion rod/tube at time of installation for example.

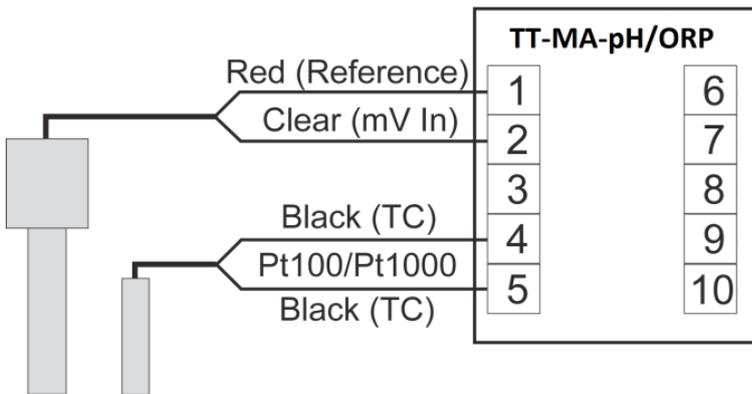
Turtle Tough has a range of installation hardware available as optional accessories including but not limited to KYNAR/PEEK Twistlock fittings, Stainless Steel Immersion Rods, Stainless Steel Sanitary Sensor Holders & Extension Tubes and Valve Retractable Assemblies. Contact your Turtle Tough Distributor for technical support on the optimal installation hardware to suit your application.

Please Note: Avoid excessive force for those pH/ORP sensors fitted with Spanner Flats

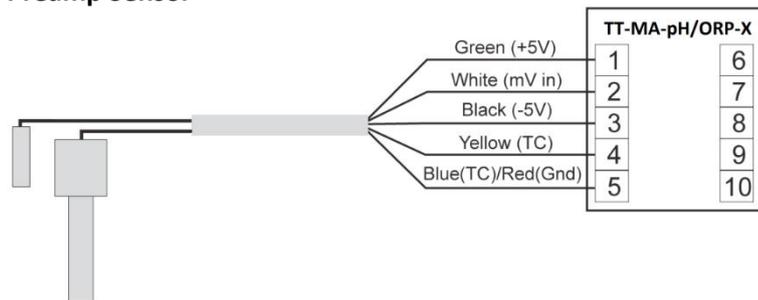
Wiring

Turtle Tough pH/ORP sensors are designed to provide optimal life when connected to a TT-MA Online Analyser or TT-pHP Portable Meter. Connection to the TT-pHP is via BNC and banana plug connectors. Wiring of non-preamp, preamp and external preamp sensors to the TT-MA are as follows:

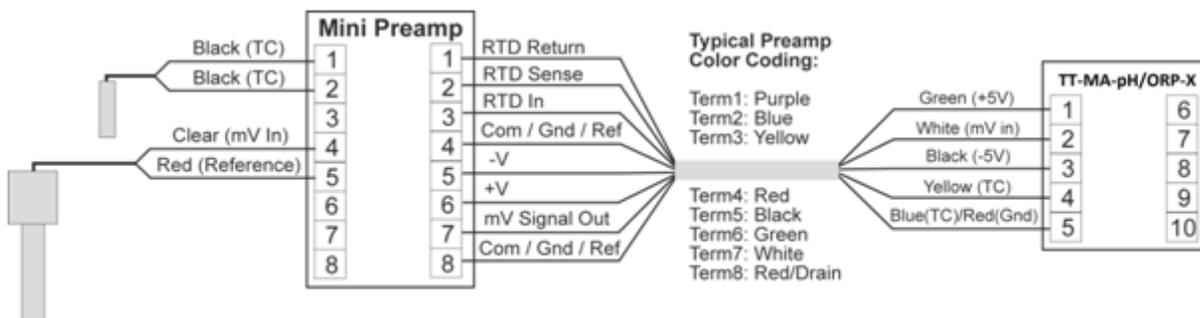
Non-Preamp Sensor



Preamp Sensor



External Preamp Sensor



Note: Please consult the Turtle Tough website (www.turtletough.com.au) for additional wiring information.

Calibration

This section covers calibration of Turtle Tough pH & ORP sensors when mated with a TT-MA Analyser Module. If you are using a different analyser please consult the manual supplied with the unit or the Turtle Tough website (www.turtletough.com.au)

pH Calibration - Buffer and Slope Adjustment

Ensure software lock is **Off** prior to commencement. Using **Mode** select **Buffer** and calibrate to the first solution value by using the **Up** and **Down** keys. The recommend pH buffer for calibration is 6.86 (preferred) or 7.00. Next, using **Mode** select **Slope** and use the **Up/Down** keys until the display reads the second solution value, typically using pH buffer 4.01 (when measuring pH<7) or pH Buffer 9.18 (preferred) or 10.00 (when measuring pH>7).

Enabling dual slope mode is recommended when the process media frequently crosses the pH 7 boundary. The dual slope mode is disabled (**Off**) by default, but can be enabled by setting parameter P08 to the **On** state. When dual slope is enabled, the pH sensor is calibrated at three points: one near pH 7 (in **Buffer** mode), then in a pH buffer below pH7 (in **Slope** mode) and then in a pH buffer above pH7 (in **Slope** mode). **You must exit the Slope mode by using the mode key after completing the acidic slope (below pH7) calibration before entering the alkaline slope (above pH7) calibration.**

The **Buffer** calibration can achieve a process offset whereby the online reading can be made to agree with any grab sample analysis. All calibrations are saved instantaneously as they are performed so there is no “save” or “enter” operation required. Note that a two (2) second dampener exists for both calibrate modes and a ten (10) second dampener for the measure mode.

The temperature can be calibrated by pushing the **Up** and **Down** buttons when in the temperature display (°C) mode provided the software lock is **Off**.

ORP Calibration

Unlike pH two point calibrations which establishes offset and slope, an ORP Calibration is a single point offset adjustment.

Ensure software lock is **Off** prior to commencement. Using **Mode** select **Slope** (Note: Buffer will not be an option) and calibrate to the mV value of your prepared calibration solution by using the **Up** and **Down** keys.

Fresh mV Solution is required to ensure accurate calibration. Unlike a pH buffer they do not self- stabilise and deteriorate in air. Solutions will maintain ideal values for about two hours.

Troubleshooting

There are many potential issues that are involved in the uncertainty of an online pH/ORP measurement. Some of the most common possible issues are summarised below and may be applicable to your particular installation.

Raw mV Display

For troubleshooting it is often useful to access the raw uncompensated mV potential of the pH sensor. When assisting you with a diagnosis, a Turtle Tough representative may ask you to place the analyser into the **Raw mV Display** mode. This can be accessed by pressing the **Down** key in the main pH/mV display mode. The display now changes from pH to mV units. Negative values will be displayed as flashing.

Common Thermal Related Issues

Make sure that the online industrial sensor is in thermal and chemical equilibrium with the process before making any one-point offset calibration. Please note that sensors that run in hot processes should be allowed to cool down to room temperature before performing a 2-point calibration. The temperature indicated on the sensor can be used as a gauge of when it is ready to proceed with a calibration having reached a thermal equilibrium with ambient conditions. Calibrating a pH sensor when it is not at thermal equilibrium is a very common cause of calibration error.

Common Offset Type Issues

If the display of the online sensor diverges from the lab expected reference value it is possible to force agree between these two readings with the TT-MA-pH transmitter even after a calibration has been performed with pH buffers. Such a one point grab sample type offset calibration is performed when in the **Buffer** LED mode. Navigate with the **Mode** key to the **Buffer** mode while the pH sensor is installed into the process and while the reading is quite stable. Use the **Up** and **Down** keys to adjust the displayed value to agree with the laboratory determined reference value if desired. Such a grab sample offset type calibration should only be performed after all pH buffer calibrations have been completed.

pH Buffer Accuracy & Stability Issues

It is important to consider that some pH buffers degrade in quality much more quickly than others when left open to air, or with exposure to heat and/or light. In particular, both commonly used pH buffer 7.00 and 10.00 are notorious for losing the accuracy of their values when exposed to the air, sunlight or just simply degrade with time. In contrast, the 4.01 pH buffer is a well-known VERY stable pH buffer and so is the industry default standard for both conditioning and spot 1-point tests for pH sensors. One important step to ensure accurate calibrations with pH buffers is to check whether the buffers employed are still within the expiry period and that they were stored in a cool, dry storage location away from sunlight.

In addition to the 4.01 pH buffer, the 6.86 and 9.18 pH buffers are amongst the most stable pH buffers

available. It is strongly recommend colourless pH buffers be used rather than the more common coloured pH buffers. If coloured pH buffers are used for calibrations, it is important that they are NOT also used as the conditioning solution in which pH sensors are stored (this should be reserved for colourless type pH buffers). For higher value pH buffers (10+) it is recommended to purchase only smaller amounts (to ensure that they stay within expiry) and keeping them stored in a sealed container in a cool, dry place. This minimises the absorption of carbon dioxide from the air that can alter the value of these high pH buffers. In general, the higher value pH buffers are very unstable, much as the very low pH buffers also tend to be rather more unstable. The best available option for calibration of pH above 10 is the 12.45 type pH buffer. The best available option for calibration of pH below 4 is the type pH buffer. For general purpose calibrations, the MOST stable pH buffers are 4.01 and 6.86 and to a lesser degree 9.18. If the preferred 6.86 or 9.18 buffers are not available, then 7.00 and 10.00 buffers can be substituted with some slight loss of precision due to the differences in relative pH buffer stabilities.

pH Buffer During Calibration

Since the TT-MA-pH/ORP transmitter does not automatically correct for the temperature effects on your particular pH buffer, you will need to manually enter the correct buffer pH value at your particular temperature to ensure optimum accuracy during the calibration process. Each pH buffer solution is always labeled with the pH value at various temperatures so that you can adjust the pH to the appropriate number. Temperature compensation on the TT-MA-pH does not account for the change in the pH buffer values due to temperature and so this correction must be done manually.

Temperature effects on pH Reading

More generally, note that temperature compensation for pH mode ONLY accounts for the change in potential of the pH sensor itself due to temperature. Any other temperature induced changes to the pH of any given solution (such as changing the effective mean activity coefficient or equilibrium of the process media or pH buffer) are NOT accounted by temperature compensation and thus must all be considered separately. Lastly, for ORP measurements there exists no temperature compensation at all meaning that temperature displayed is simply for reference purposes.

Sensor Maintenance

Maintenance Free

Turtle Tough pH and ORP sensors are a completely sealed assembly and are sealed for life. This provides extreme process resistance as well as a totally maintenance free sensor which greatly increases sensor life and reduces labour costs. A Turtle Tough sensor does not contain any O-rings, washers, gaskets, or serviceable components/assemblies. It does not require refreshing or refilling of electrolyte. The only requirement is regular cleaning in accordance with our recommended cleaning schedule for your application. Regular cleaning will prolong the life of your sensor and ensure hassle free operation.

Storage

The standard shelf life for all Turtle Tough pH and ORP sensors is one year from the date of shipment. Sensors stored longer than this period may still be functional but are no longer under warranty. Sensors should be stored in a cool, dry location with the sensor tip (sensing element) oriented toward the ground. All sensors

come standard with a conditioning solution in the cap. This conditioning solution is 50% pH 4 buffer and 50% saturated potassium chloride (mixed by volume). The sensor cap should be kept tightly affixed to the sensor body and sealed with common PVC tape when the sensor is not in use. Sensors that are to be returned for shelf life warranty claim must have the original sensor cap and conditioning solution intact to be eligible for warranty replacement.

Cleaning a Turtle Tough pH/ORP Sensor

Recommended Cleaning Schedule

The recommended cleaning interval is based upon the difficulty index for your application. Please contact your agent or refer to the website to identify your difficulty rating.

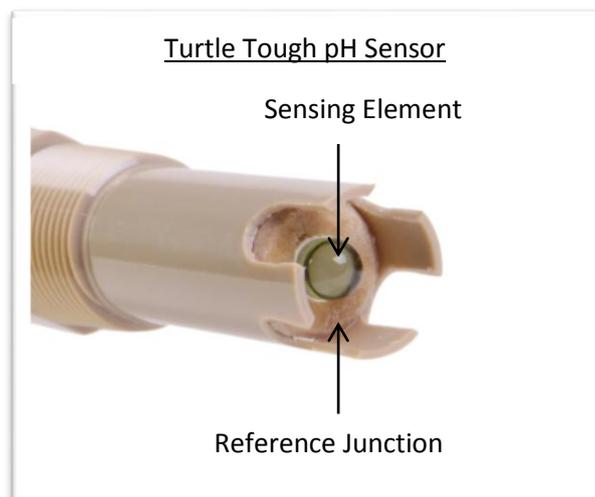
Application Difficulty Rating	Cleaning Schedule
1-3	Monthly
4-6	Fortnightly
6-7	Weekly
8-9	Twice (2x) per week
10	Daily

If a Turtle Tough pH/ORP sensor response slows down, it is most likely the result of a fouled reference or dirty coated glass. Cleaning should be performed as required and will vary across applications.

Cleaning

Cleaning requirements will vary depending on the application for which the sensor is used. The following should always be observed when cleaning:

- Never scratch or aggressively scrub the pH or ORP (sensing) elements. These are delicate glass electrochemical electrodes. They can be easily broken by mechanical force
- The reference junction is a solid state material and can be cleaned with aggressive chemicals. See list below of recommended cleaning solutions. This solid state reference can also be cleaned effectively by using a sharp razor edged tool
- Great care should be taken not to scratch the pH glass or ORP element during cleaning of the reference junction



Common approved cleaning solutions include:

- 5-15% Hydrochloric Acid – (For Alkaline deposits)
- 5-15% Sodium Hydroxide – (For Organic Contaminants)
- Surfactant (non-ionic soaps such as micro-90)

Please contact your local Turtle Tough representative if you plan to use any other cleaning agent

Avoiding Thermal Shock

For high temperature applications where process liquid exceeds 70°C you will prolong the life of the sensor by avoiding thermal shock. Thermal shock occurs when you rapidly change the temperature of the sensor from hot to cold or vice versa. This rapid expansion/contraction of sensor components can damage internal elements and cause micro-cracking that will accelerate the rate of deterioration. In extreme cases it will crack the sensing element causing a total failure. To avoid this, the sensor should be heated or cooled slowly during removal/insertion and cleaning and calibration processes. Consult your Turtle Tough representative for techniques to avoid thermal shock.

Conditioning for Calibration

After the sensor has been cleaned, it must be thoroughly rinsed with deionised water to remove any residual cleaning reagents. The sensor can then be soaked in pH 4 buffer to recondition the pH and reference elements. Some sensors will also require conditioning in saturated potassium chloride if the reference junction has been depleted of the ions in the solid state conductive polymer (typical for clean water applications). Condition the sensor in saturated potassium chloride and/or pH 4 buffer for whatever period of time is required to achieve optimal calibration results.

Warranty Statement

Product Warranty

Every Turtle Tough product is thoroughly inspected and tested before leaving the factory and prior to shipping. In addition to any statutory rights and remedies you may have, Turtle Tough warrants all of its products against defective workmanship and faulty materials for 12 months from the date of purchase and undertakes, at its option, to repair or replace, free of charge, each product or part thereof on condition that:

- The complete product is returned to Turtle Tough or one of its authorised service agents, in person or freight pre-paid by you, and found, on examination, to be suffering from a manufacturing defect
- The product or relevant part has not been subject to misuse, neglect, or been involved in an accident
- The repairs are not required as a result of normal wear and tear
- Damage caused by wear and tear, inadequate maintenance, corrosion, or by the effects of chemical processes is excluded from this warranty coverage

The above warranty excludes sensors. Please see sensor warranty below.

Sensor Warranty

Turtle Tough sensors are electrochemical devices and as such have a limited operating life. Life expectancy depends on the field of application such as the medium, pressure and temperature. It can vary between a number of weeks to several years. There are special cases in extreme environments where operating life will only be a few days. Characteristic and response times will also change with aging.

As such electrochemical sensors are articles of consumption and are not subject to a common guarantee. Replacements or exchanges are generally excluded unless a manufacturing defect is determined to be the cause.

It is not possible to predict the rate of deterioration for a particular process, nor can we provide a guarantee on sensor life because it is impossible to predict the rate of exposure, contamination and deterioration. Damage caused by wear and tear, inadequate maintenance, corrosion, or by the effects of chemical processes is excluded from this warranty coverage.

Our agents or representatives may provide you with a life expectancy guide based on similar applications we have experienced; however this in no-way constitutes a warranty of performance and is a general indicator.

Shelf Life Warranty

The standard shelf life for a Turtle Tough sensor is one year from the date of shipment. Sensors stored longer than this period may still be functional but are no longer under warranty. Sensors should be stored in a cool, dry location with the sensor tip (where the pH/ORP element is located) oriented toward the ground. All pH/ORP/ISE sensors come standard with a conditioning solution in the cap. This conditioning solution is 50% pH 4 buffer and 50% saturated potassium chloride (mixed by volume). The sensor cap should be kept tightly affixed to the sensor body and sealed with common piping teflon tape when the sensor is not in use. Sensors that are to be returned for shelf life warranty claim must have the original sensor cap and conditioning solution intact to be eligible for warranty replacement.

Performance Warranties

Life Expectancy Guarantee

For some applications we will offer a minimum life expectancy guarantee. Consult your local agent or representative for further information. Where a minimum life expectancy is suggested, Turtle Tough will provide a limited performance warranty based on:

- Submission of a complete and accurate application questionnaire prior to purchase, approved by a Turtle Tough representative
- The sensor must be installed in accordance with our recommended guidelines
- The sensor must be installed on a Turtle Tough 3TX analyser with data logging capabilities
- The sensor has been regularly cleaned and calibrated in accordance with our recommended schedule (as evidenced by the data logger)
- Data logging information is provided by you

Lowest Cost of Ownership

For some applications we can offer a fixed price guarantee. If you are prepared to disclose your total annual spend on sensors, we will submit a fixed cost agreement to deliver the same measurement capabilities at a lower overall cost, fixed for the term of the agreement. This is an immediate guarantee of costs savings. Please contact your representative for a lowest cost of ownership guarantee proposal.

Blown Pre-Amplifiers

Damaged preamplifiers are not covered under warranty. Preamps are electrical devices that are sensitive to electrostatic discharge. Sensors with preamps are clearly marked and extra care must be taken when handling these sensors as human contact with the electrical connections can discharge static to the preamplifier causing it to blow. This will render the product inoperable. Sensors with preamplifiers undergo additional quality checks prior to shipment to ensure that preamplifiers are 100% operational upon delivery. Ground loop or analyser problems may also cause blown preamplifiers and damage to sensors by faulty installations is not covered by warranty.

Return Goods

For all return goods the following information must be included in the letter accompanying the returned goods:

- Model Code and Serial Number
- Original Purchase Order and Date
- Length of time in service and description of the process
- Description of the fault and circumstances of the failure
- Process/environmental conditions that may be related to the failure of the sensor
- Statement as to whether warranty or non-warranty service is requested
- Complete shipping and billing instructions for return of material, plus the name and phone number of a contact person that can be reached for further information
- Clean Statement Returned goods that have been in contact with process fluids must be decontaminated and disinfected prior to shipment. Goods should carry a certificate to this effect, for the health and safety of our employees. Material Safety Data sheets must be included for all components of the process to which the sensor(s) have been exposed

IMPORTANT!

Please note that for sensors, cables must NOT be cut or this will void the warranty. The cable contains a unique identifier laminated to the cable end, and if this is removed we have no way of tracing the product. Sensors dying or expiring in the course of use is not covered by the product warranty.

Support

For technical support please contact the Turtle Tough head office 1300 781 701 or visit our website www.turtletough.com.au