OxyGuard®

CO2 Portable

Carbon Dioxide Analyser

USER MANUAL

Ser. Nr.:

Range: 0-50 mg/l

Output: 0-1 V

Delivery

Checked by:

1. DESCRIPTION

The OxyGuard CO2 is an analyser designed to measure the gaseous dissolved carbon dioxide content of water in fish farms and similar. The range of the instrument is as standard set to 0-50 mg/l. The instrument can be delivered with other ranges.

The OxyGuard CO2 Portable consists of a Probe, a Transmitter with display, a battery charger, an output lead and calibration accessories. The transmitter has a 0-1VDC signal as output. This 0-1V signal corresponds to 0-50 mg/l. Calibration accessories consist of a calibration beaker with stirrer, calibration solution, pH conditioner dosing syringe for use during calibration and a measure for dosing pH conditioner.

The OxyGuard CO2 is calibrated both in zero and span. Zero calibration is performed in water that does not contain any free dissolved CO2. Span calibration is performed in the same water to which a precise amount of CO2 has been added. Since it is difficult to add a precise amount of CO2 in gaseous form to water, a precise amount of a chemical is added and then the chemical is treated with pH conditioner to make it release CO2.

Using the OxyGuard CO2 is easy - just switch on, put the probe in the water and measure. It will take a few minutes to obtain the correct value. The display shows the milligram per litre free carbon dioxide in the water.

When the probe is in the water the instrument MUST ALWAYS be switched ON.

We would like to add that tests with the OxyGuard CO2 analyzer have shown that the traditional methods of determining CO2 by titration have their limitations. These methods were designed for boiler feed water analysis. Boiler feed water is - or should be - quite pure, and does not contain dissolved solids that can affect a titration. The water found in fish farms, however, contains many compounds that can interfere with titrations. Ammonia, ammonium, phosphates, humic acids, urea, silicates and chlorides are examples. More information on this subject is found later in this manual.

The OxyGuard CO2 is temperature compensated in a similar way to a dissolved oxygen meter. The compensation range is from 3 to +35°C.

The OxyGuard CO2 measures only free dissolved carbon dioxide. It does not consume CO2 for its measurement and does not change the pH or any other property of the water.

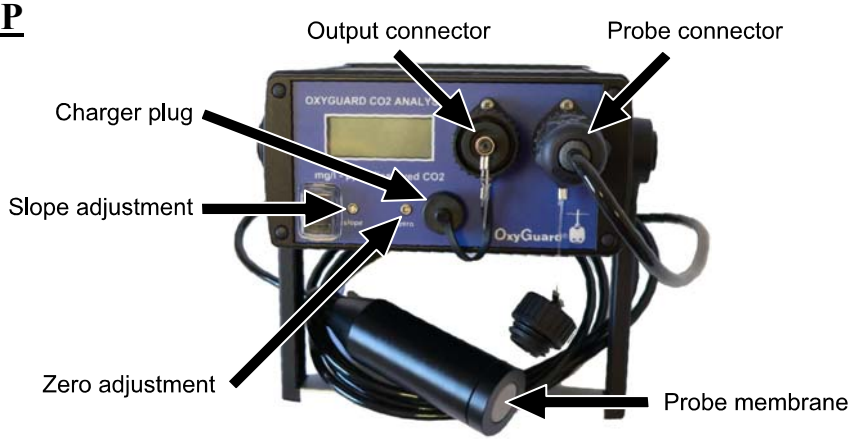
Carbon dioxide dissolves in water both chemically and physically.

The chemically dissolved CO2 is part of the carbonate system in the water and is as such harmless.

The physically dissolved CO2 is the CO2 that affects the fish, and is the CO2 that is measured by the OxyGuard CO2 analyzer.

IMPORTANT
If you try to measure the CO2 content of aquaculture water by titration, you will not only measure CO2, but also any other substance in the water that can affect the titration. You will obtain a result that is too high

2. STARTING UP



Please note the following:

2.1.1 THE ANALYZER IS DELIVERED CALIBRATED AND READY FOR USE. WE RECOMMEND THAT YOU USE IT AND BECOME FULLY FAMILIAR WITH ITS USE BEFORE YOU CHECK THE CALIBRATION FOR THE FIRST TIME.

NB. The OxyGuard CO2 is splash-proof, NOT immersion-proof.

2.1.2 THE PROBE HAS A RELATIVELY LONG RESPONSE TIME. TYPICAL VALUES ARE A FEW MINUTES IN MOVING WATER AND 15 MINUTES IN STILL WATER.

2.1.3 WHEN THE PROBE IS IN WATER THE INSTRUMENT MUST BE SWITCHED ON.

2.1.4 THE COVER OVER THE CHARGER PLUG SHOULD BE PULLED OFF, NOT TURNED.

2.1.5 THIS IS A SENSITIVE INSTRUMENT. KEEP POINTED OBJECTS AWAY FROM THE PROBE MEMBRANE.

2.1.6 DO NOT ATTEMPT TO OPEN THE PROBE – THIS WILL DAMAGE IT AND VOID ANY GUARANTEE.

Keep the probe reasonably clean - wipe it or wash in household detergent if necessary. If carbonate deposits appear on the membrane add 1 tsp. of the pH conditioner supplied to a small cup of water and leave the probe in it until the deposits have gone. Remember to keep the instrument switched on when the probe is in water.

2.2 Charging

The unit is shipped ready for use, but may need charging before being taken into use. Chargers can differ - for example, the charger for use in North America differs from the charger for use in Denmark. Some chargers have in indicator that lights when charging is complete, others indicate when charging is taking place. Please see the charger for information of the actual type of charger.

2.3 Switch On Sequence

When you switch the Portable CO2 analyzer on it will perform a switch-on sequence lasting about a minute. The display can show various values during this time. We advise that you simply switch on and wait two minutes and then use the instrument.

2.4 Analogue Output.

The 0-1V analogue output is obtained by inserting the plug of the output lead into the output connector. The brown lead is plus, the blue lead is minus.

NB. The voltage on the analogue output can go above 1 V and below 0V.
For example, during the switch on sequence -0.4V is likely, and if the probe is not connected -3V can appear.
The output can source about 50 mA. Please ensure that connected equipment can tolerate this.

2.5 Use as a Bench Top Instrument

If you need to make measurements in more than one tank or body of water we recommend that the OxyGuard CO2 is used as a bench top instrument, where the analyser remains in the laboratory and samples are taken to it. This enables the instrument to remain switched on continuously, and avoids subjecting it to changing temperatures etc. and the mechanical stress of being moved from one place to another. Tests show that water with about 50 mg/l carbon dioxide remains stable in the calibration beaker with the stirrer switched on for almost 30 minutes, and that the error introduced by removing the sample and measuring in the laboratory rather than on-the-spot can, with care, be kept to one or two mg/l.

We recommend that samples are taken in glass bottles with tight fitting stoppers (e.g. screw caps). The samples should be transferred to the calibration beaker and the CO2 content measured. For the greatest accuracy let the samples attain the same temperature as that the calibration water had during calibration. The samples should, however, preferably be measured within an hour or two.

Care must be used when taking the samples and when pouring them into the calibration beaker. Tilt the beaker and pour so that the sample runs smoothly down the side of the beaker with as little aeration as possible.

Make sure that the stirrer magnet is in place, tilt the beaker a little and insert the probe. Make sure that there are no air bubbles trapped under the probe - if there are, lift the probe a little and tilt the beaker to let the bubbles escape. Start the stirrer.

When the reading is steady, which normally takes less than 10 minutes, note the value. You can then stop the stirrer and discard the sample.

3. CALIBRATION

NB THE ANALYZER IS DELIVERED CALIBRATED AND READY FOR USE. WE RECOMMEND THAT YOU USE IT AND BECOME FAMILIAR WITH ITS USE BEFORE YOU CHECK THE CALIBRATION FOR THE FIRST TIME.

Other than measurement, calibration of zero and span are the only functions that the user can perform..

For calibration you need the following:

- -Calibration beaker with stirrer as supplied.
- -Prepared water.
- -pH conditioner as supplied.
- -Calibration fluid in bottle as supplied.
- -Dosing syringe as supplied.
- -Measure for pH conditioner as supplied.

NB It is very important that the cap of the calibration fluid bottle is kept tightly closed.

3.1 Preparing Water for Calibration

The calibration procedure overleaf will ensure a correct zero calibration, but any CO2 or impurities in the water will entail a "Slope" calibration error.

Water that is purged for carbon dioxide by saturating it 100% with fresh air or pure nitrogen, is used during calibration.

Distilled (or effectively demineralised) water must be used.
Do NOT use tap water, sea water, well water or similar - these almost certainly contain substances that can affect calibration.

NB. Commercially available demineralised water can contain both large amounts of CO2 and unknown amounts of salts, especially if the ion exchanger used when making the water needed regeneration. Sometimes demineralised water is sold as distilled water.

Take 1 litre distilled water and aerate it: place an air stone in the container and connect it to a source of clean compressed air. The compressor intake should be in free air, outdoors, away from sources of carbon dioxide. A heavy-duty aquarium pump can also be used - make sure that it pumps **fresh** air. Aerate for at least 30 minutes and the water is ready for use.

Purging with air removes any CO2 in excess of that corresponding to air-saturated water (i.e. 0.4 mg/l).

Please note that air taken from inside a building or in an urban or industrial area may have an elevated carbon dioxide content. For scientific work or similar you should use pure nitrogen instead of air.

If you will measure in salt water add salt to the water - 1 gram per litre per ppt. You can use a paperweight to weigh the salt. You must use PURE salt - do NOT use "Instant Ocean" or similar.

To make up salt water add pure salt to 1 litre of demineralised water as follows:

Add g/l	for salinity ppt
5	5
10	10
15	15
20	20
25	25
30	30
35	35
40	40

Please contact OxyGuard if you have any questions regarding the above.

Remember - no measurement is more accurate than the calibration - so be careful when calibrating!

3.2 Calibration

3.2.1) Take the calibration beaker and make sure that the stirrer magnet is in it. Use the dosing syringe supplied to dose 1 ml calibration solution into the beaker. Replace the cap on the calibration solution bottle immediately.

3.2.2) Pour 199 ml of the prepared water into the beaker. The water level will now be to the top of the ring.

3.2.3) Plug the lead into the charger connection on the meter to start the stirrer. Stir for 10 seconds.

3.2.4) Disconnect the stirrer and insert the probe into the beaker. Re-connect the stirrer and observe the reading on the meter.

Please note that if a vortex of bubbles is trapped under the probe lift the probe a little. Hold the probe and beaker at a slight angle and disconnect the stirrer. The bubbles will escape. Replace the probe and connect the stirrer again.

3.2.5) Wait for the display to settle. When the display has settled adjust the "Zero" potentiometer until the display shows "000".

3.2.6 Disconnect the stirrer and lift the probe up.

3.2.7) Use the measure supplied and add one dose of pH conditioner to the water.

3.2.8) Start the stirrer. Stir for 10 seconds.

3.2.9) Disconnect the stirrer and insert the probe into the beaker. Re-connect the stirrer and observe the reading on the meter. If needed remove any bubbles as described above.

3.2.10) Wait for the display to settle. When the display has settled adjust the "Slope" potentiometer until the display shows 050. Check that the reading does not rise after a minute or two, re-adjust if this is the case.

3.2.11) To check the prepared water empty the calibration beaker and fill it with prepared water with no calibration solution. Insert the probe and stir. Check the reading - it should be 0. If it shows more than 1 further aeration of the prepared water is needed and the calibration procedure should be repeated.

NB. Fresh distilled water, i.e. steam condensate, does not contain CO2 unless it has been exposed to the air.

The procedure described here will, if followed correctly, always give a correct zero calibration.

The accuracy of the span calibration depends on how carefully the water has been prepared (see 3.1).

To check the prepared water measure its CO2 content after calibration has been performed - see 3.2.11).

3.3 How often should calibration be performed?

This depends on the actual conditions, how the analyzer is used and the accuracy wanted. The OxyGuard CO2 is a stable instrument and keeps its calibration well. We recommend that you become familiar with the instrument before you check the calibration for the first time.

4. SPECIFICATIONS

Size:	Probe: 40mm dia. x 140 mm. Cable length 3m. Meter: 120 x 120 x 58 mm Calibration beaker 65mm dia. x 260 mm
Weight	Approx. 7 kg including charger, calibration fluid, calibration conditioner, calibration beaker and dosing syringe.
Supply (to charger)	230VAC (115VAC on request).
Range	0 - 50 mg/l dissolved carbon dioxide. Temperature compensated range 3-35°C.
Output:	Analogue signal 0-1VDC
Operating conditions:	Electronics -10 to +60°C, splashproof.
Accuracy	Depends on calibration. Expected practical accuracy +/- 1 mg/l when calibration temperature = measuring temperature.
Response time	Typically 5 minutes at 20°C depending on flow velocity past probe. In still water up to 15 minutes.
Flow requirements	The instrument does not use carbon dioxide for its measurement, but a certain flow is necessary to ensure that the sensing element of the probe is in equilibrium with the surrounding water, and to avoid "spot" measurements.
Operating time:	Approximately 70 hours on fully charged batteries.

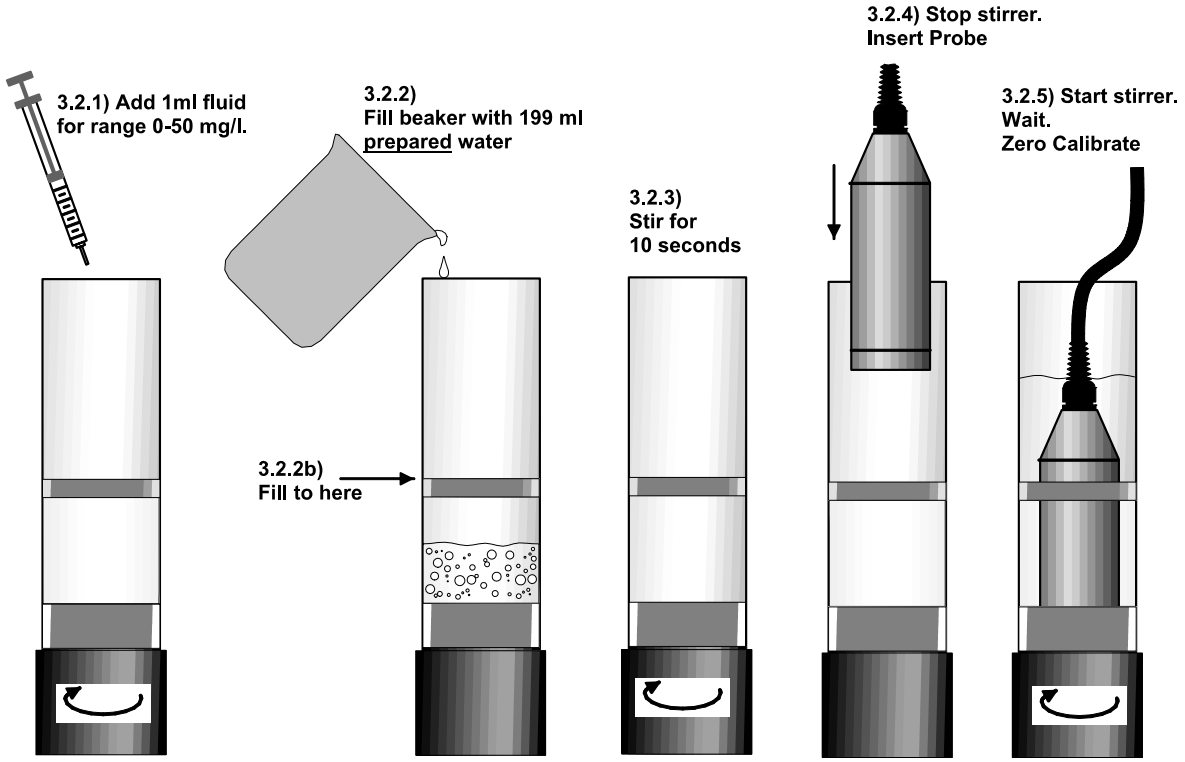
Analyser comprises: Transmitter and probe with 3m cable, charger, analogue output lead.
Calibration accessories comprise: Beaker with stirrer & magnet, 75 g calibration conditioner, 100 ml calibration solution, dosing syringe, measure, adjustment screwdriver.

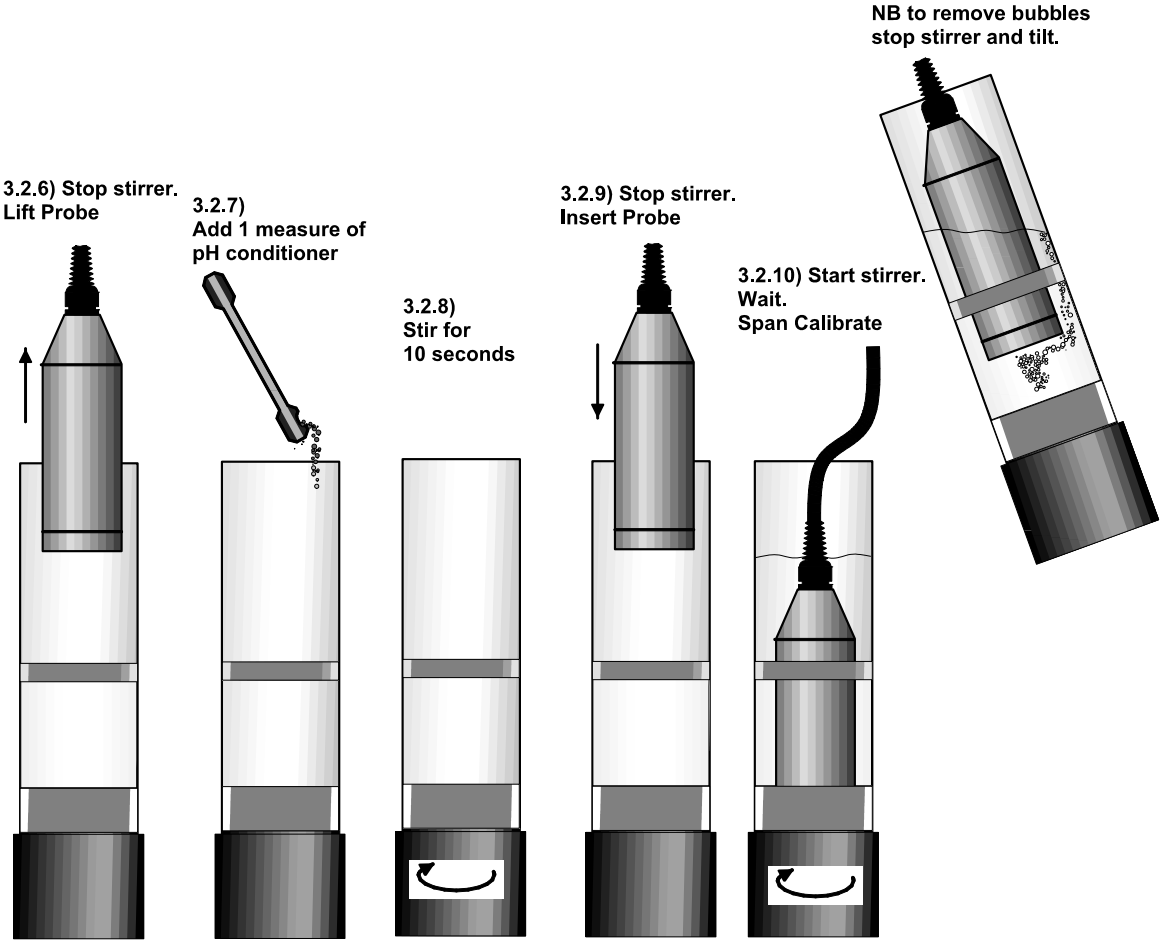
Spares and accessories:

G02ST	Calibration beaker with stirrer and magnet. For 12VDC.
G02STC	Charger for battery pack for 230VAC, other on request.
G02XCT	75 g calibration conditioner.
G02XCS	100 ml calibration solution.
G02XCD	Dosing syringe.

data subject to change without notice

CALIBRATION





ABOUT THE MEASUREMENT OF CO_2

General

CO_2, both naturally occurring and from piscine respiration, dissolves in the water in two ways, chemically and physically. The chemically dissolved part forms hydrogen carbonate and hydrogen ions, and this is balanced by the physically dissolved part which is present as CO2 gas dissolved in the water just as oxygen is dissolved in the water. The equilibrium has the form:

$$CO_{2(g)} + H_2O \leftrightarrow HCO_3^- + H^+$$

The $CO_{2(g)}$ is in gas form; **it is this CO_2 that the fish are subjected to and react to**. The $CO_{2(g)}$ exerts as such a gas pressure, so if this pressure is measured the gaseous CO_2 content of the water in mg/l can be determined.

With the OxyGuard CO2

The probe of the OxyGuard CO2 contains a pressure sensor that is selectively sensitive to the gas pressure of CO_2. It is completely insensitive to oxygen, nitrogen, argon, water vapour or any dissolved gas found in the water other than CO_2. The sensor is located behind a gas permeable membrane that does not allow any ionic species to pass, so the OxyGuard CO2 only reacts to the $CO_{2(g)}$.
The OxyGuard CO2 thus measures the CO_2 that affects the fish.

By Titration

Chemical methods for the determination of dissolved CO_2 are based on titration of a sample, either with base to pH 8.2 or by acid to pH 4.3. Both methods work well, but only on pure water such as boiler feed water, for which the methods were developed probably as long as a hundred years ago. If the water contains anything else that can affect a titration then a titration will give a too high result.

Aquaculture water contains many different substances that interfere with the above mentioned titrations, either by consuming base or by consuming acid. Phosphates, ammonia and ammonium interfere strongly, but silicates, borates, humic acid, urea and other substances also interfere. Titrations on aquaculture water will thus always react both to the $CO_{2(g)}$ and to other substances in the water.

The only easy way of measuring the $CO_{2(g)}$ in aquaculture water accurately is to use the OxyGuard CO2.

When CO_2 in aquaculture is measured with the OxyGuard CO2, therefore, one obtains lower values than those obtained by chemical methods.

More information is found in the article "A comparison of methods to determine dissolved CO2:Direct measurement versus chemical determination" (available from OxyGuard).