
Measuring

Dissolved Oxygen in Wine



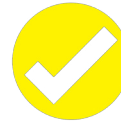
Find out all you need to know about
measuring Dissolved Oxygen in winemaking



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Introduction

What is dissolved oxygen?

Oxygen is an essential part of life, playing a key role in many biological and chemical reactions. Dissolved oxygen (DO) describes the amount of free molecular oxygen (O_2) dissolved in solution, usually expressed in milligrams per liter (mg/L), parts per million (ppm), or percent saturation (% sat).

Managing wine's exposure to oxygen is crucial to crafting a fine tasting product. While small amounts can enhance flavors, creating a softer texture and introducing dynamic tastes, it is best to keep levels of dissolved oxygen as low as possible. Oxygen exposure can be beneficial during fermentation, but can be detrimental and should be minimized during movement, fining, bottling and aging of wines.

How much is too much?

The concentration of molecular oxygen measured in the wine before bottling should ideally be less than 0.5 mg/L.⁵





Introduction

What influences oxygen's presence in solution?

Oxygen is present everywhere, the atmosphere is made up of 21% oxygen along with other gases including nitrogen. The degree to which oxygen will dissolve into wine when exposed to air is influenced by its temperature and atmospheric pressure.¹ pH plays a role in determining how oxygen reacts once already present in the solution.

Air Exposure	Exposure to air results in an increase of dissolved oxygen uptake. The level of increase is dependent on pH, temperature and atmospheric pressure.
Temperature	Cold temperatures increase oxygen solubility in wine, while the reverse is true for warm temperatures.
Atmospheric Pressure	Oxygen solubility in wine is highly dependent on partial pressure between the wine and the atmosphere. As atmospheric pressure increases, the rate at which oxygen dissolves into a solution increases.
pH	As the pH of wine increases and becomes more alkaline, the effectiveness of molecular SO ₂ as an antioxidant is greatly lessened. This means there is more unbound oxygen present in the wine, thus increasing the chance for oxidation to occur.

Hanna Note

At standard atmospheric pressure and temperature, wine reaches oxygen saturation at 6mg/L. ⁴

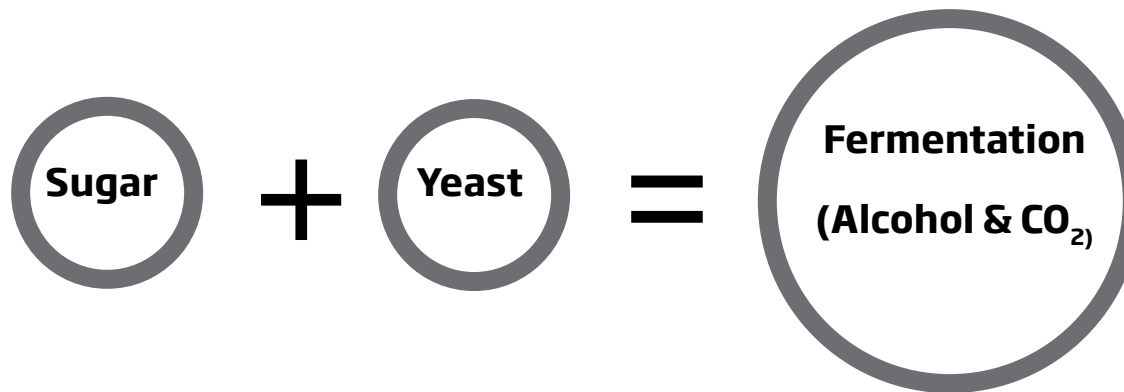


Why Dissolved Oxygen Matters

1 How does oxygen affect wine quality?

Fermentation

- Oxygen can stimulate fermentation in the first few days by improving the permeability of yeast cells to take in more glucose.¹
- The presence of molecular oxygen is required for the synthesis of lipids and steroids essential for functional cell membranes.⁵



Hanna Note

The fermentation stage is one of the few points at which oxygen introduction can provide a benefit.



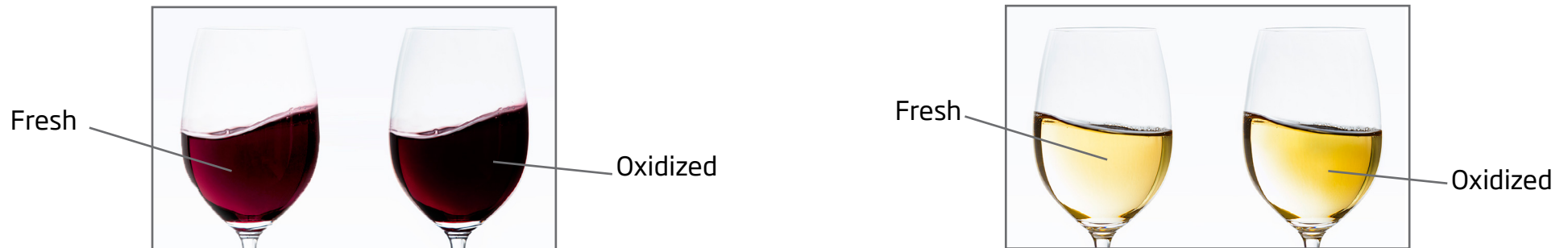
Why Dissolved Oxygen Matters

2 How does oxygen affect wine quality?

Color

Dissolved oxygen can react with phenolic compounds to form quinones which can affect the color of the wine. As oxidation progresses, the rate of color change will slow until stabilization is achieved.

- In white wines, phenols such as catechins and leucoanthocyanins are converted to brown pigments, sometimes producing an undesired haze.⁵
- Pinking, the name given to the development of a red blush in white wines, is the result of rapid conversion of flavenes to their corresponding salts due to the reduction of oxygen.⁵
- Color can precipitate out in red wines, resulting in a lighter finished product. Anthocyanins polymerize with other flavonoids causing reds to take on a brick-red or brown color.¹



Hanna Note

Not all oxidation is the result of dissolved oxygen in wine; some is the outcome of other redox reactions. For instance, the further browning due to the presence of metals, such as copper, in wine.



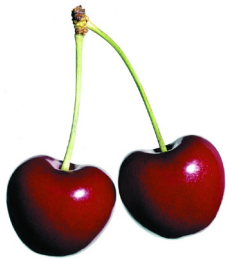
Why Dissolved Oxygen Matters

3 How does oxygen affect wine quality?

Aroma, Flavor, and Texture

Excess oxygen results in:

- Loss of fruit characters¹
- Reduced or altered aroma
- Increase in bitterness as a result of the development of acetaldehyde



Cherries



Strawberries



Orange Peel



Cinnamon



Vanilla

Commonly observed fruit flavor profiles in wine.



Why Dissolved Oxygen Matters

4 How does oxygen affect wine quality?

Chemical Composition

The introduction of oxygen results in:

- **Lower antioxidants**
- **Formation of acetaldehyde:** On average, red wines contain 30 mg/L, white 80 mg/L, and Sherries 300 mg/L. At low levels acetaldehyde can contribute pleasant fruity aromas to a wine. At higher levels the aroma is considered a defect, resulting in a rotten-apple like smell.²
- **Microbial spoilage:** Exposure to oxygen allows unwanted bacteria and yeast such as *Acetobacter aceti*, Lactic acid bacteria, and *Brettanomyces* to thrive.



Why Dissolved Oxygen Matters

5 Where is oxygen introduced during the winemaking process?

Oxygen can be introduced into wine at various stages during the process. Possible points include:



Crushing and Pressing: The physical process of removing the grape pulps from skins, seeds, and stems can cause high amounts of oxygen to be introduced into the must or juice.



Fermentation: During this stage, red musts can go through a “pumpover” or “punch down” to allow for pigment and compound extraction from the grape skins and, in some cases, the addition of oxygen to stimulate fermentation.



Racking, Pumping, and Filtration: Oxygen is introduced when wine is moved from one container to another. Small amounts of oxygen can enter through the porous membranes of filtration pads and diatomaceous earth systems, while mechanical pumps and loose fittings can introduce oxygen into the wine as the product is moved.



Why Dissolved Oxygen Matters



Cellar Aging: This is typically done in wood barrels or stainless steel containers. Wood barrels can result in the slow addition of oxygen through the porous wood as compared to stainless steel tanks.



Bottling: Oxygen must be closely monitored to ensure minimal impact on wine quality during final filtration, filling of bottles, and closure procedures. This is the final stage at which oxygen can be unintentionally introduced, thus having a detrimental effect on the finished product



Bottle Aging: Oxygen present in the headspace of bottles or let in through closures can spoil wine over time. Closure styles are an important consideration when trying to maintain the quality of bottled wine.

- Screw top: Consistently lets in very little oxygen
- Natural cork: Oxygen transmission varies depending on quality. High quality cork lets in very little oxygen while lesser quality lets in more.
- Synthetic stopper: Allows oxygen to enter into the bottle at higher rate than a screw top or natural cork closure.³



Why Acidity Matters

6 At what points during the winemaking process should oxygen be measured?

There are several stages where it is important to measure dissolved oxygen:

- 1) During racking and tank movements.
- 2) Before and after filtration.
- 3) Throughout the aging process.
- 4) After processing and before bottling.
- 5) In the final, bottled product.

Monitoring levels of dissolved oxygen at these points not only helps to produce a fine tasting wine, but also ensures equipment efficiency throughout the production process.

7 How can oxygen levels be minimized?

There are ways to control oxygen exposure and thus reduce levels of dissolved oxygen in wine.

Oxygen Displacement: Empty lines, tanks, and bottling equipment can be flushed of oxygen with the use of inert gases before filling. Nitrogen, carbon dioxide, sulfur dioxide and argon are the most commonly used gases due to their ability to displace oxygen. Frozen CO₂ and dry ice can be used to blanket equipment, keeping oxygen from entering. Sparging, or the passing of small N₂ bubbles through the wine itself, displaces dissolved oxygen molecules (as well as other gases), reducing their levels.

Antioxidant Treatment: Sulfur dioxide (SO₂) can be added to wine where it binds with dissolved oxygen, making it more difficult for oxidation to occur.



What You Need

Ideal Testing Setup - Materials

Equipment

- 1) DO meter
- 2) Clark type DO probe
- 3) Compact magnetic stirrer
- 4) Lab ware
- 5) Lab washbottle

Solutions

- 1) Zero Oxygen Solution
- 2) Electrolyte Fill Solution





What You Need

Clark Type Polarographic Dissolved Oxygen Probes

Polarographic probes consist of a silver/silver chloride (AgCl) anode and a platinum (Pt) cathode immersed in an electrolyte solution. When a voltage is applied to the electrolytic cell, a current proportional to oxygen concentration is produced. The electrical current is then converted into an oxygen concentration measurement.

Pros:

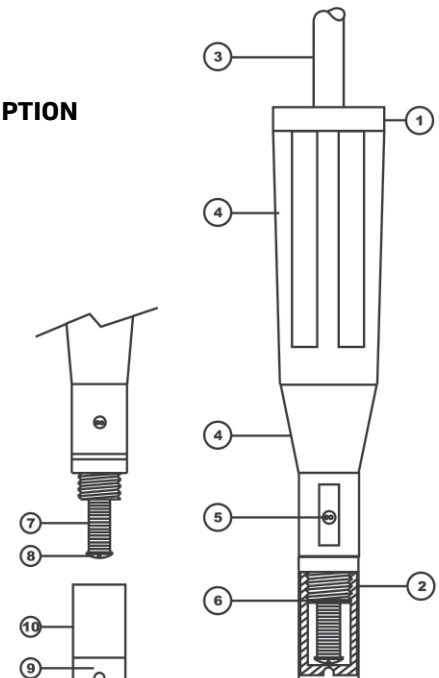
- Direct measurement of oxygen
- Replaceable PTFE membrane caps
- Built in thermistor for temperature compensation
- Robust probe for long life

Cons:

- Requires conditioning (polarization warm up time)
- Requires sample flow

PROBE FUNCTIONAL DESCRIPTION

1. DO Probe
2. Protective Cap
3. Watertight Shielded Cable
4. Polypropylene Probe Body
5. Temperature Sensor
6. O-Ring Seal
7. Silver Chloride Anode
8. Platinum Cathode (sensor)
9. Oxygen Permeable PTFE® Membrane
10. Membrane Cap





What You Need

Choosing the Right Probe

When choosing the correct probe for measuring DO, it is important to consider the points at which measurements will be taken.

For use in large tanks:

Any probe will work such as the Hanna Instruments HI76407 Polarographic DO Probe which has a 25mm wide submersible body.

For direct measurement in bottles:

It is essential to use a thin-body design that allows the probe to fit directly into the bottle or packaging. The HI76483 has a 12mm ultrathin design making it ideal for applications where size is an issue.



- Electrochemical based probe
- Integrated temperature sensor



- Application specific design (slim, submersible)





What You Need

Choosing the Right Meter

When choosing a DO meter, there are a number of options offered by Hanna Instruments to help make measuring DO fast, easy and accurate.



- Temperature compensation
- Two point calibration
- Automatic calibration



- Barometric Pressure Compensation
- Logging capabilities
- USB for transferring data
- Good Laboratory Practice (GLP)

Hanna Note

Barometric Pressure Compensation: Changes in pressure are automatically detected by a built-in barometer. These pressure values are used in calculating the amount of DO present.
Altitude Compensation: The user is able to manually enter the altitude at which they are measuring. Programmed tables containing the relationship between DO and altitude are used in calculating the amount of DO present.



What You Need

HI9142

DO Range:

- 0.00 to 19 ppm mg/L (ppm)

Features:

- Rugged waterproof design with large graphic display
- Up to two point automatic calibration
- Automatic temperature compensation (ATC)



Recommended for cellar use



What You Need

HI98193 Waterproof Portable Dissolved Oxygen

DO Range:

- 0.00 to 50.00 ppm (mg/L), 0.0 up to 600.0% saturation

Features:

- Rugged waterproof design with large graphic display
- Submersible, polarographic probe (HI764073)
- Up to two point automatic calibration
- Automatic temperature compensation (ATC)
- Automatic barometric pressure compensation
- Good Laboratory Practice (GLP)
- Logging capability (up to 400 readings)
- USB for transferring data to a Window's PC



Recommended for cellar use



What You Need

HI5421 Dissolved Oxygen Benchtop Meter

DO Range:

- 0.00 to 90.00 ppm (mg/L), 0.0 to 600.0 % saturation

Features:

- Slim, polarographic probe (HI76483)
- Up to two point automatic calibration
- Built in Barometer for automatic pressure compensation
- Automatic temperature compensation (ATC)
- Good Laboratory Practice (GLP)
- Data logging (up to 1,000 readings)
- USBs for transferring data to a flash drive or computer



Recommended for lab use



What You Need

HI7040L Bi-Component Zero Oxygen Solution

Use a high-quality zero oxygen solution for calibration, especially for applications that involve testing low levels of dissolved oxygen.

A clearly marked:

- Lot number
- Expiration date

To ensure:

- Quality
- Traceability



Hanna Note

A bi-component zero oxygen solution consists of two parts that are mixed together prior to use. Keeping the two components separate allows for a long shelf life. Once both components are mixed together the zero oxygen solution will need to be discarded within one month.



What You Need



HI7041M
Electrolyte Fill Solution

Fresh electrolyte fill solution is a must have in order to have a properly working probe. The fill solution in the probe cap needs to be replaced at least once per month.



HI764080A/P
Spare Membrane Screw Caps

These oxygen permeable polymer membranes are easily filled with electrolyte or installed on Hanna's polarographic dissolved oxygen probes.



What You Need

Magnetic stirrer:

Clark Type probes require flow past the DO membrane in order to produce accurate measurements. A magnetic stirrer with variable speed control and micro stir bar will allow for sample mixing and flow past the DO membrane.



Lab ware:

100 mL beakers for samples to be tested, 500 mL waste beaker, and a laboratory wash bottle with deionized or distilled water.



How to Measure Dissolved Oxygen

1 Probe Preparation

To properly prepare a dissolved oxygen probe before measurement:

- a) Remove plastic shipping cap and discard.
- b) Condition the sensor by soaking the bottom inch of the probe in electrolyte solution for a few minutes.
- c) Inspect the membrane cap. Make sure the membrane isn't damaged.
- d) Prime the cap with electrolyte solution. Shake gently and discard.

(See Next Page)



Step 1 b



Step 1 d

Hanna Note

It is essential that there are no air bubbles on the inside surface of the membrane cap after filling. To reduce surface tension it is helpful to fill the cap with DI water and let stand for a few hours before priming the cap with electrolyte solution.



How to Measure Dissolved Oxygen

- e) Make sure to seat the rubber o-ring properly inside the cap.
- f) Fill all the way with new electrolyte solution.
- g) Flick the cap with your fingers to release any air bubbles that may have formed at the surface of the membrane.

(Do not touch the membrane itself as this may damage it).



Step 1 e



Step 1 g

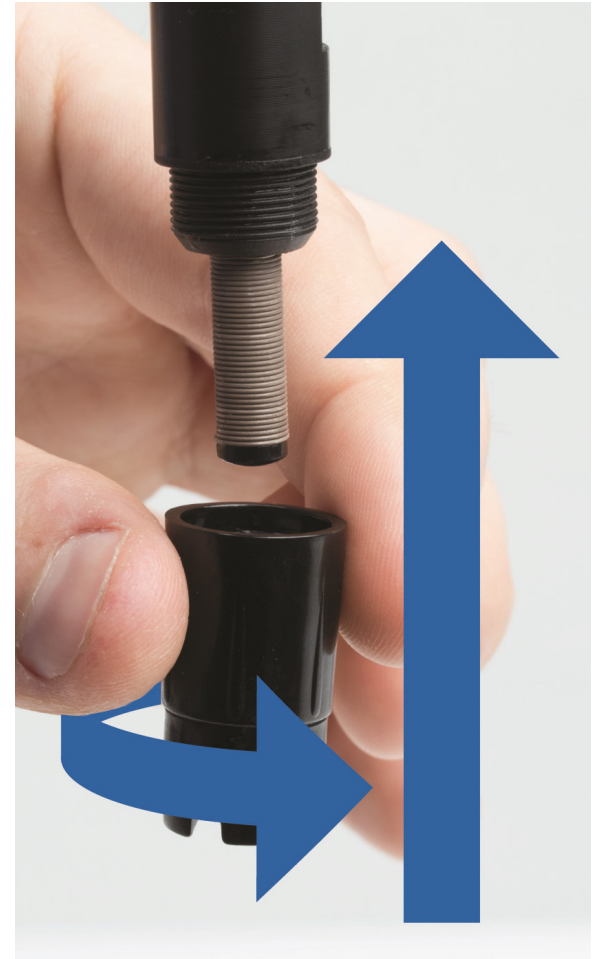
Hanna Note

It can be helpful to use a pencil or small screwdriver to tap the sides of the cap, helping to release air bubbles.



How to Measure Dissolved Oxygen

- h) With the sensor facing downward, slowly screw the membrane cap upward and counterclockwise (some electrolyte will overflow).
- i) Rinse the outer body of the probe and inspect membrane for entrapped gas bubbles.
- j) Connect the DO probe to meter and turn meter on. Allow 15 minutes for probe conditioning (polarizing) function to occur.



Step 1 h



Hanna Note

During polarization, oxygen present in the electrolyte is consumed that may otherwise lead to inconsistencies in calibration and measurement.



How to Measure Dissolved Oxygen

2 DO Calibration

One point automatic zero calibration at 0% saturation

- a) Prepare a fresh bottle of zero oxygen solution by following package directions.
- b) Pour enough zero oxygen solution to cover the temperature sensor.
- c) Make sure the meter is on and properly polarized.
- d) Set the appropriate altitude factor and set the salinity value to zero.
- e) Submerge the probe past the temperature sensor and stir gently for several minutes until the reading goes down and becomes stable.
- f) Once stabilized, perform and confirm the 0% DO calibration.



Step 2 e

Hanna Note

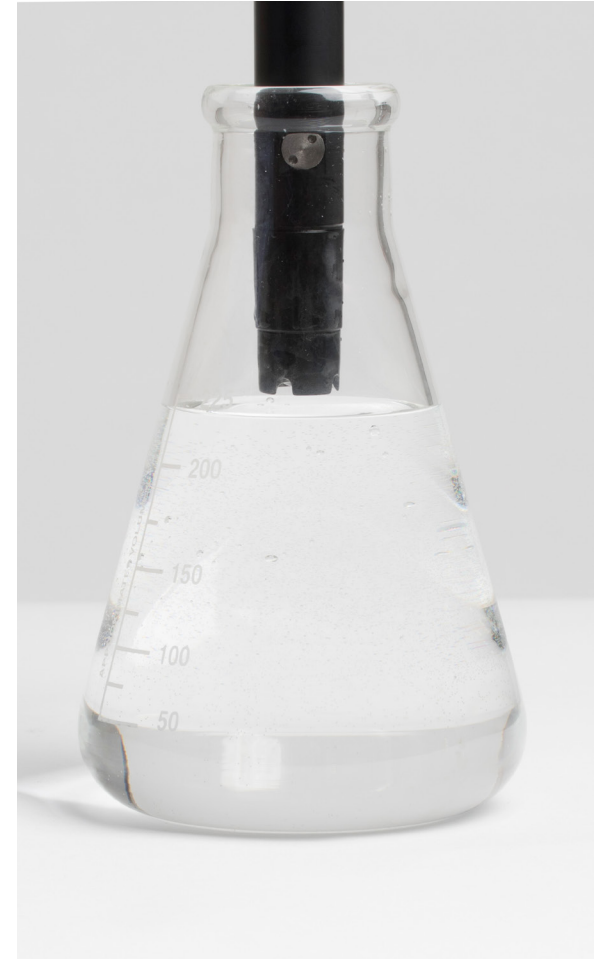
Hanna uses a bi-component oxygen solution that is activated when two separate components are mixed together. Supplying this reagent as individual components provides for a longer shelf life before use.



How to Measure Dissolved Oxygen

One point automatic slope calibration at 100% water saturated air

- i) Pour a small amount of water into a beaker or flask.
- ii) Keeping the probe facing downward as normal, hold the probe over a sample of water but do not submerge it.
- iii) Once stabilized, perform and confirm the 100% DO calibration.



Step 2 ii

Hanna Note

This calibration should not be performed over the zero oxygen solution.



How to Measure Dissolved Oxygen

3 Taking a DO Measurement

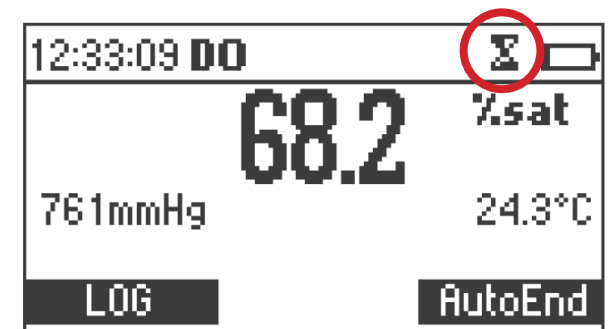
- Make sure that the probe is polarized, calibrated, and the protective cap has been removed.
- Submerge the probe past the temperature sensor into the sample and stir gently.
- Allow time for the reading to stabilize.
- Record or log reading.



Step 3b

4 Probe Storage and Care

- Once you are finished measuring your samples, rinse the probe with deionized water until clean.
- Always be sure to put the clear protective cap back on until the next use.



Step 3c

Hanna Note

For the most accurate dissolved oxygen measurements, create water movement in the sample by using either a magnetic stirrer and stir bar or gently stirring by hand.



How to Measure Dissolved Oxygen

Measurement Practices

Analytical testing can easily be integrated into the wine production process. Being able to log and recall data points along with calibration information can be of great importance to winemakers.

Good Laboratory Practice (GLP): The GLP feature found on Hanna's DO meters offers the ability for the user to monitor when the DO probe was last calibrated and to what points. This information is stored with logged data.

Calibration Time Out: Some meters offer the user the option to set a reminder for calibration. The user can select a time frame from 1 to 7 days. Once this set time runs out, the meter reminds the user that a new calibration is due.

Last DO cal	Standard
Date: 03-Feb-2006	0.00mg/L
Time: 11:39:38PM	8.26mg/L
Salinity: 1 g/L	
Pressure: 761mmHg	
Temperature: 24.3°C	
Cal Expire: Disabled	

Measure DO with Confidence!

Buy the HI5421 and get the bonus solution pack which includes HI7040L Zero Oxygen Solution Set (500 mL) and HI7041M Dissolved Oxygen probe electrolyte solution (230mL) bottle

Plus get FREE shipping.

Use Discount Code: WineDO
Offer Expires: 6/23/16

\$910
Free
Solution Pack
(a value of \$60)
+ Free
Shipping



To get your new DO meter - [Click Here](#)



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THANKS FOR READING!

Our experts are here to help you.

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