ANALYSE THAT!

9 WAYS TO GET SAMPLING

Used by the many, bought by the few – but would you be safer having an oxygen analyser of your own? JOHN BANTIN tests eight of these useful devices

A DIVER'S LIFE USED TO BE SIMPLE. You had your tank filled with air. It was normally clean filtered air. If you inhaled and got clean air, everything was OK. If it had an oily taste, you felt sick during the dive. If it was contaminated with carbon monoxide, you died.

Generally speaking, you breathed in and out and tried not to run out before you surfaced.

Air is a mixture of inert nitrogen and oxygen. We always had to take into consideration how much nitrogen we might have absorbed while we were under the pressure of depth.

The deeper we went, the less time we had. That was what decompression tables were for. That much hasn't changed.

Then someone (I think it was the Royal Navy during World War Two, but that's a secret) came up with the idea of nitrox. By increasing the level of oxygen in the mix that would otherwise be air, the effects of nitrogen dissolving in the body at depth are reduced, allowing, in the simplest form, longer no-stop times for any particular depth.

The first thing that novice divers ask when they hear this is whether they will get larger tanks to be able to take advantage of this fact. One could argue that if the no-stop times were kept the same as for air, an increased level of safety is introduced.

Oxygen toxicity

Increasing the oxygen level comes at a price. If you breathe oxygen at a partial pressure greater than, say, 1.6 bar, there is an increased risk of oxygen poisoning. It's not an exact science, and arguments continue about what is the safe level.

After the statistical evidence for 1.6 was put forward at the Planet Tec conference in the mid- '90s, the training agencies, ever mindful of litigation, tended to go for a maximum of 1.4 bar. With ordinary air (nitrox 21), that would give a maximum operating depth of 54m.

However, Bret Gilliam once held the record for the deepest dive using ordinary air, and that was in the order of 146m. It's been broken since.

I remember Rob Palmer doing a sequence of dives to 120m while breathing air, and it seems he got away with it for five out of the six dives (don't try this at home!). So we can only really say that oxygen poisoning may be cumulative, and affects each individual differently.

The diving world has taken to nitrox diving, thanks to membrane systems that denitrogenise air. This provides a safe and consistently produced oxygen/nitrogen mix. However, we need to know exactly what is in our tanks before we start diving, so that we can plan accordingly.

Everyone now needs to analyse their breathing gas themselves so that they can be satisfied that they have the right mix for what they are doing.

As air is now often supplied alongside nitrox, it could be argued that all divers need to analyse their gas, not only nitrox divers. You need to know that you have straight air in your tank, if that is what you want.

Analyser calibration

A nitrox analyser is, in theory, a straightforward item of kit. An oxygen sensor generates a voltage that varies according to the percentage of oxygen present. This is connected to a voltmeter that is calibrated in percentages rather than millivolts.

The analyser needs to be re-calibrated first so that it reads 20.9% O_2 with clean air passing around it. The reason for this calibration each time the analyser is used is that the reading is affected by air pressure (weather) and by the ageing of the sensor cell. If you can calibrate using a known source of pure oxygen instead of air, the sensor readings will be more accurate.

Questions arose for me from this simple technology when I found myself on an American liveaboard dive-boat with a diver who was a gas analyst from Siemens. He merely checked his tank each time to see that he didn't have air. He never waited to see exactly which

nitrox mix he had. When I asked him about this, he said he knew that the de-nitrogenised supply on board the boat could not be richer than 40% O_2, and went on to explain that the little oxygen analyser in which I had held so much faith was almost totally unable to say exactly what the mix was.

I was shocked. The problem stems from having gas flowing over the sensor. He pointed out that the gas should be stationary when measured, and that by increasing the flow, you could increase the apparent oxygen content.

Sampling

The flow of gas had to be controlled to a known rate. Cracking open a tank valve "just a little" and holding the cell over it was evidently not accurate enough for him. Temperature also makes a difference and, as you have probably noticed, gas depressurising from a tank can be very cold.

Manufacturers have made various attempts to solve the problem of getting a stationary sample of gas at the same ambient temperature and pressure as the air with which the analyser was calibrated.

Over the years I have seen divers use different methods for getting a gas sample. Some analysers use the direct-feed hose to the BC, using the regulator first stage as a flow control. It takes time to get a reading, and casual observation tells me that this method has proved unpopular with divers impatient to get in the water.

Divers will always look for the most convenient method, but we thought the blue plastic Vandagraph Quick-Ox sampling tube attached to a sensor was quite hard to beat.

I have witnessed nitrox being analysed by holding the sensor in the mouthpiece of a regulator while the purge button was pressed. Ten points for ingenuity!

Some analysers are connected to the tank via a pressure-reducing device in the form of a regulator first stage, while others simply have a hemispherical chamber with a tiny entry orifice that sits over the sensors.

All contrive a method of restricting the flow of gas over the cell, while some attempt to capture a stationary sample. It seems that the piece of plastic tube that interfaces between tank valve and sensor is very important.

Oxygen Sensors

Oxygen sensors do not last forever. Depending on how much work they do, their performance declines. Remember that even when you are not using one, if the sensor is surrounded by air, it will still be working.

These devices have a shelf life of around two years, provided their gas-barrier packaging has not been opened. They should provide a milli-volt reading between 10mV for air and 60mV for pure oxygen. Used sensors become unpredictable when they reach the end of their useful life.

Unlike sensors used in rebreathers, which might have to contend with anything from pure oxygen to very low levels, you will be analysing a gas with a pretty good idea of what its contents are likely to be, especially if it has come from a modern compressor and membrane system.

If your nitrox is made by the older partial-pressure blending system, you need to know that your analyser is exact, because there is the possibility of getting very high percentages of oxygen by mistake. It wasn't so long ago that a compressor operator asked me if rebreathers were still killing people – at the same time as he was filling my diluent cylinder with neat oxygen!

Typically, though most sensors have a life-expectancy of two years, some manufacturers now claim four to five. After that, if you get the readings you expect in that they match the claim of the nitrox supplier, you're getting a bonus.

It seems logical to keep an analyser in an airtight container, yet some experts tell me that this adds little to the lifespan of a sensor, as so many other factors need considering. Still, it does no harm.

Heat is the most detrimental factor in determining a sensor's life. Keep your analyser out of the sun, or away from any hot place.

Other factors include the cleanliness of the lead anode and the exact composition of the electrolyte. Vacuum packing and freezing have inherent risks of damage.

Some say that you should store in an inert gas but this raises questions of wake-up time for the cell after it is brought out of storage.

If you get a reading more than 1% out from your expectation, or are using a sensor that has been mishandled, do not use it to analyse the oxygen content of an unknown gas.

The Analysers

How important is it to have your own analyser? The supplier of your nitrox will need to possess one and presumably will also have one for use by customers. But for those who would prefer to carry their own O_2 analyser, we looked at some of the most commonly encountered, with a view to seeing how convenient they were to operate.

We also checked each one against the same tank of nitrox to see if there were differences.

All the analysers tested here were calibrated using the same cylinder of air, and gave a reading of our sample gas within 0.5 of a percentage point of each other.

Knowing the inaccuracy of decompression theory, that's probably accurate enough!

Vandagraph VN202

£170 with Quick-Ox, £176 with DIN tank connection (replacement cell £53)

A favourite among British divers for more than 10 years, this unit is supplied with a choice of methods for sampling gas. The sensor cell is at the end of a flexible cable and can be plugged into a conventional Quick-Ox sampling tube, with its hemispherical chamber and orifice.

The Quick-Ox has flow-turbulence-reducing diffusers and a one-way valve built in to help achieve that static gas effect, and you are meant to stop the flow to get a good sample. Otherwise it can be connected to a DIN tank connection (not a pressure-reducing valve) complete with a chamber similar to that of the Quick-Ox, and a long exit tube.

You sample by turning the gas on for five seconds and off for five seconds. The unit has an on/off button and a knob for calibration.

The cable gives the option to fix the analyser itself safely up out of harm's way on a wall or bulkhead. It proved quick and easy to calibrate. Good value.

www.vandagraph.co.uk

Vandagraph AD300

£176 (replacement cell £53)

Obviously intended for plumbing into a nitrox supply station, the sensor has a plug connection at the end of a very long flexible cable to the electrics. However, the main unit could be permanently fixed somewhere and the sensor moved to the tank valve, because the long flexible cable gives the freedom to do this. In which case, the Quick-Ox sampling tube is simply offered up to the small static amount of the gas to be analysed.

Another way is to connect the unit to the BC direct-feed hose of the regulator already fitted to the tank of gas to be analysed, using the international connection supplied.

So what happens if the mix is not what you want? You'll have to de-rig the BC from the tank. This unit is really only suitable for use on a liveaboard with a reliable de-nitrogenising membrane system. It has on/off and auto-calibration buttons plus a display-lock option, and can be set to sound an audible alarm for sensor failure/ disconnection. The display gives battery-state as well as the gas percentage.

www.vandagraph.co.uk

Vandagraph Tek-Ox

£182 (replacement cell £53)

An analyser that is designed to make its use as convenient as possible, you simply hold the attached Quick-Ox sampling tube with its hemisphere, flow diffusers and orifice over the cracked tank valve and let the gas migrate up inside the unit to its sensor cell, while most of it escapes freely out through the open end of the tube. You then turn off the tank so that the trapped sample is static. It has an on/off switch, low-battery warning and calibration control.

We found it simplest to pull off the sampling tube and wave it around in the fresh air to get an initial setting, being careful to avoid back-drafts from boat exhausts giving us errors while under way, but for the test we used a cylinder of air for calibration.

Reaction time was quick and the display big. The unit was simple, and our favourite among those intended for use by individual divers. It comes with watertight box and a quick-fitting wall-mounting bracket.

www.vandagraph.co.uk

DIVER CHOICE

Dynatron OxySpy

£199 (replacement cell £55)

Similar in concept to the simpler-looking but more expensive Nuvair, this analyser is Swiss-made and anatomically designed to make it that much easier to hold against a tank valve that could be in an awkward position.

You can use it either way round, placing the opening surrounded by soft plastic over the tank valve. The cell is positioned quite high inside the handle, in that way avoiding an undesired blast of nitrox from a carelessly opened tank valve.

It is best set to air for initial calibration by pressing a button while holding it over a known cylinder of that gas.

Knowing that divers can be lazy, the OxySpy is designed to be as convenient to use as possible. We thought the calibration procedure was a little confusing, and also quite time-consuming, although it was very convenient to use once this was done. The OxySpy uses a CR2430 battery.

Suunto Diving, www.suunto.com/diving

Analox O2EII

£200 (replacement cell £76)

A popular analyser that is often supplied on dive boats for checking your mix, this one is very neat and compact, and is claimed to be water-resistant. It is of the simplest design, in that you simply wake it up by pressing a button and calibrate it in air by adjusting a knob to get the right percentage, according to a compensation chart provided. You then offer up the sampling hemisphere of the analyser to the slightly opened valve of the nitrox tank to be checked until the reading stabilises.

This may not be the most accurate way to do it, according to the experts, but it is certainly good for confirming an anticipated nitrox mix. The unit switches off automatically, 10 minutes after use.

www.analox.net

Nuvair O2 Quickstick

£247 (replacement cell £81)

This is an analyser in its simplest form – just a plastic cylinder containing cell, voltmeter, PP9 9V battery and LCD read-out with a simple hemispherical head containing a tiny orifice that you place firmly against the tank valve after cracking it open a little.

It is calibrated for air with a fine long-handled screwdriver supplied with it.

This may seem awkward, but it retains control of calibration by the keeper of the tool for where many divers might use it under the supervision of one person. A good example would be on the aft deck of a liveaboard, where individual divers want to check what mix they have been given.

Alas, to switch it off means taking the battery out, a cumbersome operation involving removing the end and dealing with loose wires, and we feel that an individual user/owner would too easily lose the calibration tool.

Submarine Manufacturing & Products, www.smp-ltd.co.uk

Alpha-1

£249 (replacement cell £74)

This tough little unit in its anodised metal box and hanging eye was originally designed for use in conjunction with a direct-feed hose of a BC.

This was obviously too labour-intensive for most divers, so it is now supplied with a long hose complete with constriction in-line, with a connection that the user conveniently clips over his tank valve using the little elastic stirrup provided. It fitted neatly to all types of tank valve.

The unit has a blanking cap that screws over the sensor face when not in use (this might extend cell life) and a waterproofed on/off button, together with a rotating knob for calibration. It proved simplest to use a known tank of air as a supply for calibration. The Alpha-1 was a workmanlike answer to the problem of knowing what gas mix you have, and its metal construction will give it a certain longevity.

Sub Aqua Products, www.subaqua-products.com

DIVER CHOICE

OMS

£256 (replacement cell £45)

Supplied with a DIN-connection regulator first stage to operate as a pressure-reducing valve at the end of a hose, as favoured by many technical training agencies, this unit has an anatomical shape to help with holding it, an on/off switch and a rotating knob for calibration. We guess most divers would simply whip off the hose connection where it presses in at the sensor cell end and wave the unit around in fresh air to calibrate it, although we religiously used a tank of air for this purpose.

At first glance, fitting the DIN connection first stage to a cylinder seemed cumbersome, but getting an apparently accurate reading was quick and easy and free from user-error.

Divers Warehouse, www.diverswarehouse.co.uk

Vandagraph MD300

£352 (replacement cell £53)

For the diver who wants something extra, this more complicated version of the AD300 has additional test circuits for both battery condition and the audible alarm that checks for high and low readings, keeping O2 levels safely within a predetermined range.

It's really intended for installation at a nitrox supply station, and is probably unnecessarily intricate for individual users, but it certainly worked!

Like its less ambitious sibling, the MD300 can be connected either to a BC hose with an international connection or you can use the Quick-Ox sampling tube. The LCD leapfrogs digits so that the read-out is always a precise number, and there's no flickering between percentage points.

www.vandagraph.co.uk