Column by
Cedric Verdier

AS PART OF MAKING THIS ARTICLE ALL THE REBREATHER MANUFACTURERS KNOWN TO US WERE CONTACTED WITH A REQUEST TO PROVIDE US WITH THE LATEST TECHNICAL INFORMATION AND PRODUCT IMAGES. WE ALSO INVITED THEM TO OFFER ADVICE OR TIPS TO THE PROSPECTIVE BUYER. PRODUCT IMAGES IN THIS ARTICLE ARE TO A LARGE EXTENT PROVIDED BY THE MANUFACTURERS

IMAGE COURTESY OF POSEIDON

What to think about before

Buying a Rebreather

Text by Cedric Verdier
Supplemented by
Peter Symes

One morning, sooner or later, you will wake up with a strange sensation—as if some minor and weird changes happened in your body overnight. You are not turning into another Dr Jekyll and Mr Hyde, but in the recent weeks you have come to find your dives to be very noisy with all the bubbles escaping from your regulator starting to get on your nerves. All your dive gear has also started to feel very heavy, with all these tanks and regulators to carry everywhere. And then you have this fancy and expensive dive computer full of features you cannot use because they are designed for divers with little in common with you, using state-of-the-art and highly complex equipment on their back and breathing esoteric mixes coming from remote planets.

So, after reading magazines, walking your way along many booths in the dive shows, surfing the net looking for rebreather-related websites, you have finally arrived at an important threshold in your life. You are ready to buy a rebreather. You have made up your mind, checked that the mortgage for your nuclear bunker is in place and you won't have to replace your two-year-old pink Jacuzzi anytime soon. What do you do then? Asking yourself the following questions is a good place to start:

Do I really need a rebreather?

It might sound like a strange question, but it is an important one nonetheless.

Take a peek at the internet forums and mailing lists and you'll discover a lot of people selling their expensive and brand new rebreathers. Why? The reason stated most of the time is that the present owner just doesn't use it! Yes, you read it correctly. After months of research and comparisons of products, prices and offers, and after making a financial investment equal to the one needed for buying a small car, a lot of divers discover that they don't really need it, or it's too much of a hassle—they don't have time, or they don't like it. So, it is better to think twice beforehand, weighing cost against benefits, taking into consideration what types and frequency of the dives you usually do or plan to do. Points to consider should include:

The type of diving you do. Using a rebreather can make a lot of sense for a diver who spends a lot of time doing deep wreck dives or long video dives. But does it also make sense for short and shallow reef dives in a tropi-

cal environment? Only you can answer that question. But consider the hassle of travelling with a rebreather (even a small one!), filling nitrox or oxygen tanks, buying scrubber, preparing the unit before the dive, cleaning it afterwards and what not. All that work for something that can possibly be done just as easily with a single tank you can rent anywhere!

The number of dives you do. Consider the initial investment for a rebreather, plus the maintenance (batteries, O_2 sensors, yearly regulator maintenance). Then divide this number by the number of dives you do in the span of three years, which is the average time people own a specific rebreather. Then add the additional expenses for each rebreather dive (scrubber, tank fills, etc). If you end up with a cost per dive very close to your monthly salary, it might be wise to consider sticking with your current open diving open circuit.

The Dräger Dolphin is possibly the best known and most widely produced semi closed rebreather. Introduced in the mid 1990s, the design is now beginning to show its age in comparion with more contemporary models

There is no way around it: Rebreathers need proper care

Your complacency level. There is no way around it—rebreathers need proper care. And they can be temperamental pieces of equipment. After some dives on open circuit, don't expect to come back to your rebreather and find it working flawlessly. Chances are that something will not be working properly as it was before. It is necessary to dedicate some time to your rebreather—for maintenance, pre-dive and post-dive checks and routine skills underwater. So, if you spend more time brushing your teeth in the morning than preparing, checking and properly packing your diving equipment, you'll have to change your habits if you want to dive with a rebreather. If post-diving maintenance means having a nap after the dive to you, then rebreather diving is not for you.

PETER SYMES

"Lt. Lund II" A military oxygen-rebreather from 1954

What type of rebreather do I need?

There are about as many rebreather models on the market now as three-syllable words in a Rambo movie. These rebreathers are either semi-closed rebreathers (SCR) or fully closed circuit (CCR) rebreathers. In the recent years, the favor of the public has gravitated towards the fully closed-circuit rebreathers. Firstly, the once significant price gap between the SCRs and CCRs full bred units have narrowed over the years. Secondly, the performance and accessibility of the CCRs have kept improving.

Purely mechanical SCRs constantly loose gas by every exhalation, and they work by providing a constant percentage of oxygen—something that is not as ideal as CCR from a decompression standpoint. Therefore, the current trend is still that fewer SCRs are being built, with CCRs clearly being the preferred choice overall.

Aside from some very specific applications, pure oxygen CCRs are not used in sport diving because their use is limited to a maximum depth of only six meters. (Any deeper than that, the partial pressure of the pure O_2 reaches toxic levels). That leaves two main types of CCRs to share the scene: mCCRs (manually operated CCR) and eCCRs (electronically controlled CCR). The main difference lies in the manner by which oxygen is injected in the breathing loop:

mCCR

Most of mCCRs rely on a tiny constant feed of O_2 into the loop making the content safe to breathe. The user has to frequently check the loop content on a display showing the pO_2 readings from a set of (most often three) oxygen sensors and manually inject more oxygen if necessary to keep oxygen content at the correct levels. These rebreathers are simple and reliable but require the diver to constantly keep a close eye on the oxygen monitors.

eCCR

eCCRs are more complex units using a computer (sometimes several) to constantly monitor the oxygen level in the breathing loop and electronically maintain a pre-determined constant pO_2. This level is known as a "setpoint". What type you choose may in part depend on the contents of your piggy bank, as eCCRs are more expensive than mCCRs. Also, the type of dives you do means something, as eCCRs are usually less depth-limited than mCCRs. It may also be a matter of which degree you are comfortable with relying on electronics under water.

POSEIDON

Granular absorbent you pour into your scubber yourself (left). Cheaper, but care most be taken to pack the scrubber correctly. Prepacked cartridges (right) are more expensive but more convenient and always correctly packed

Which features should I look for in a CCR?

This is where we get technical. So, to spare you long nights of ploughing through heaps of technical brochures, graphics, curves and test results, let's get right to point.

Counterlungs

These are the 'bags' on the breathing loop where your exhalation goes. The shape and position of these determine some of the breathing characteristics and how easily you breathe in different positions underwater. Some rebreathers have the counterlungs back-mounted, giving a nice chest-free configuration. This configuration aids exhalation but makes inhalation harder. The opposite is true for chest-mounted counter-lungs.

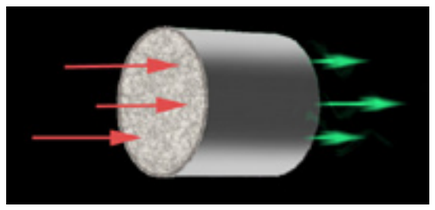
Others have them configured "over-the-shoulders" for a better work of breathing, but a more encumbered chest. In any case, the counterlungs should be positioned as close to your real lungs as possible to minimize work of breathing (See info box). Some manufacturers also provide the option of different sizes of counterlungs. Size is another another trade-off, which has to be balanced. Too small and you may find yourself in a struggle to get enough gas, too large and they create a lot of unnecessary drag.

Counterlungs

Scrubber

One of the most important components of the unit, the scrubber canister holds the absorbent (i.e. Sodalime) which absorbs the exhaled CO_2 cleaning up the gas you'll breathe. You can choose between granular absorbent that you pour into the canister yourself or solid state cartridges, which you just slide in as a whole package.

There are also different scrubber architectures—axial or radial. An axial scrubber is essentially a wide cylindrical pipe through which gas flows from one to the other in a 'vertical direction'. In a radial scrubber, gas flows in a radial direction from a central pipe at the hub and towards the side of the canister.



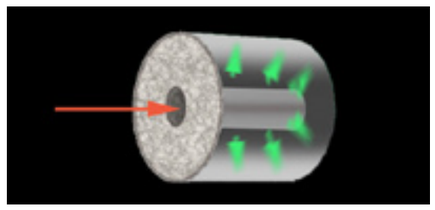


Illustration of the two main scrubber architecture: Axial or radial. Red is exhaled air with CO_2. Green is 'scrubbed' gas

Radial has a longer duration and is generally considered to offer a lower breathing resistance. Scrubbers, too, come in different sizes. A bigger scrubber gives you more time underwater, or more reserve for the same duration.

Duration?

Probably one of your least concerns. Chances are you will be starving long before your scrubber expires. Unless you are a technical diver planning very long dives, most scrubbers will outlast any dive you can endure before you crave the next meal or need to go to the bathroom. It is mostly a matter of convenience and how often you need to change. A typical scrubber will last you 4-6 hours depending on the size of the canister and the temperature of the water.

Golem Gear's radial scrubber unit for the Megalodon CCR is almost a piece of art. The breathing gas comes down the center axis and then traverses radially through the absorbent and through the grid

Granular absorbent or prepacked cartridges?

To some extent, this is a matter of choice of economy versus convenience. Pouring granules and packing the scrubber is not outright messy but a bit of manual work. It can also be contended that prepacked cartridges are packed uniformly and correctly by a manufacturer ensuring that channelling won't happen. (see box next page). But there is not always an option. There aren't cartridges available for each and any size of canister or rebreather, while some rebreathers, i.e. the Poseidon CCR, only accepts proprietary cartridges.

Work of breathing and counterlung position

A new method of counterlung evaluation presented by Dr Dan Warkander, US Navy, breaks down the common concept of breathing effort into three constituent breathing factors that must be evaluated for closed circuit systems.

- **Resistive effort** describes the burden of pushing or pulling gas through the breathing loop—think of the difference between breathing through a soda straw and a snorkel.
- **Hydrostatic Loading** describes the relative difference between the pressure center of the diver's lungs and the maximum and minimum pressure differentials when the counter lung is fully inflated and fully emptied.
- **Elastance refers** to the change in shape of the counter lung as its volume changes during a breath.

Each of these three elements causes the diver to do work when breathing. Lower work of breathing is a design objective to avoid fatigue from just breathing.

In a normal swimming position, the hydrostatic load of back mounted counter lungs produces negative lung loading—it is hard to inhale but easy to exhale. Chest mounted counter lungs produce positive lung loading where the inhalation is easy but exhaling requires more of an effort. Over the shoulder counter lungs provide the best compromise reducing lung net loading to zero.

As regards to resistive effort, small diameter air passages have higher resistance to flow. So does elbows, long tubes, flow direction mushroom valves and thick scrubber beds. Using a sufficiently large diameter tubes throughout the breathing loop, avoiding too many bends and elbows and a radial scrubber all reduce resistive effort. Since a large flat counter lung has a lower elastance than a long narrow tube standing vertical in the water column, once again the shoulder counter lung configuration seems to offer the best trade-off. ■

Gas supply

All CCRs have a small tank of oxygen and a small tank for air or other diluent. Some units are able to use different tank sizes, depending on what you find locally. Other manufacturers make their units with a "hard-case", which leaves just enough room for a specific size and shape of cylinder. Once again, size matters—even for rebreather tanks, as these tanks are also being used for inflating BCD and possibly a drysuit, too. And even if the rebreather diver carries an off-board bailout tank for emergencies, the on-board tank might also be used as a backup in a bailout emergency. In any case, the more gas, the better!

Electronics

This is the area in which the changes and advances have been the most impressive in the last few years. SCRs and mCCRs usually display simple pO_2 readings. eCCRs, on the other hand, tend to have more advanced displays with redundant pO_2 and set-point reading, built-in decompression softwares with Open Circuit bailout capabilities, battery level indication, O_2 sensors voltage and even scrubber monitoring. Just make sure you can easily read the most important information!

This photo is meant to illustrate the differences in length between the Evolution and Evolution+ scrubbers but also clearly shows the typical tank configuration. The oxygen tank is on the right. The diluent—in this case, air—is on the left. Tanks shown are 2-liter

Make sure you can easily read the most important information!

Upgrades

Can your electronics be upgraded? Rebreathers constitute a substantial investment, so it is nice to know whether it can be upgraded or updated and at what cost. Fortunately, much of the software can now be upgraded by the user at home by downloading files from the manufacturer's website and installing them via some interface.

Vision electronics for the Inspiration and Evolution CCRs are upgradable over the internet

Too small for bailout

Diluent bottle for bailout?

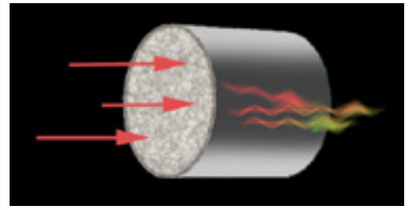
When diving a rebreather, at anything but very shallow depths, a separate bailout bottle should always be carried. The diluent bottle, even when using a larger than stardard diluent cylinder, does not provide an adequate bailout gas supply for emergencies. The emergency bailout cylinder should be an open circuit gas in a separate cylinder i.e in the form of a sling tank.

Quite unique: Steam Machines use an analogue pO_2 meter as its secondary system on its Prism CCR

Electronic display from a Pelagian rebreather

What is channelling?

Channelling happens when the scrubber material packs unevenly leading to the creation of a path—or 'channel'—of least resistance through which the breathing gas may move as a focused flow without being properly filtered. This can lead to a CO_2 breakthrough much sooner than the nominal duration time for the scrubber. The mere action of pouring



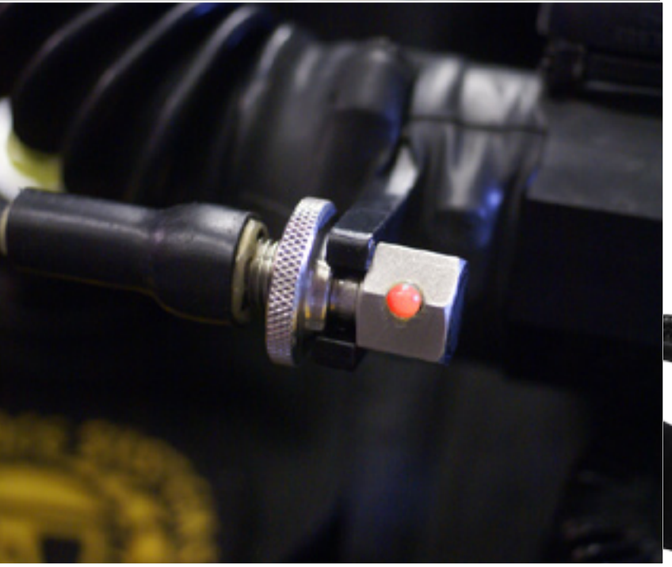
Improper packaging of absorbent can create a channel

the granular scrubber into the canister can lead to some sorting of particles according to size, not unlike how stone, sand and gravel are sorted out in zones on a beach. For this reason, it is very important to go about filling the canister as instructed including tapping the canister to make the material settle uniformly. Tapping it after transportation is usually also a good idea.

Measuring CO_2

One of the main functions of a rebreather is to filter out your exhaled CO_2—the other is, obviously, to provide you with the correct concentrations of oxygen. If CO_2 builds up in the breathing loop, you'll soon end up in a very uncomfortable and dangerous scenario. So, why not have a sensor monitoring CO_2 in the same manner that we have O_2 sensors, may you ask? Because the necessary technology doesn't yet exist.

Instead CO_2, or rather the risk of scrubber expenditure, is monitored in a roundabout way. As CO_2 is being absorbed by the scrubber, a chemical reaction takes place that produces heat, which can be felt as warm band across the canister. The position of this warm band moves down the canister as the scrubber gets spent giving an indication of remaining scrubber duration. The position of this zone of active CO_2 absorption can then be traced by temperature sensors giving some kind of readout to the diver. When the warm zone gets closer to the bottom, the scrubber is about to be spent and needs to be replaced. This technique, it should be stressed, says nothing about the actual CO_2 content in the loop. ■



Head up display (HUD) on a Megalodon rebreather serves as an alert to any issues with the unit the user should be made aware of or react to

A bailout valve (BOV) allows you to change from breathing from the closed circuit to an independent open circuit. The BOV has a regulator second stage to be attached upon the rebreather mouthpiece (not shown here). Changing from closed to open circuit is then done by a flip of the switch with no need to remove the mouthpiece.

A BOV can either come as an accessory that you can retrofit on the unit such as the Golem Germ BOV mount shown on the right. Or they come as a standard and integrated feature as seen on the Poseidon / CIS-Lunar Discovery (left)

Are there any other additional features I may want?

HUD

Most of the rebreathers on the market come with some forms of safety devices like visual and audible alarms. However, not all come with a Head-Up Display (HUD), which is a very nice way to monitor your loop content without using your hands, something very handy when you take pictures, hold on a shotline in a strong current, or play cards during a long decompression stop.

BOV

A Bail-Out Valve is a rebreather mouthpiece combined with an open circuit regulator second stage. Even if you carry a bailout tank and regulator, this regulator might not be immediately available when you need it—you could be dangling from something, entangled or the bailout is already being used by your buddy. The BOV gives you the ability to immediately switch to Open Circuit by flipping a switch if something goes wrong with your rebreather and you find your breathing loop filled with an unbreathable gas mix or even water. It is a highly desirable extra feature, as some divers have reported that some symptoms of intoxication showed up as the inability to think properly and to quickly locate their alternate air source.

Off-board plug-in

When it comes to gas supply and avoiding depletion, the more options you have, the better. Some rebreathers allow you to plug in the loop any gas tank you might find, as long as it has a standard LP hose fitted. This gives you some flexibility when dealing with what shouldn't become an emergency with a rebreather.

This is an adaptor that enables a fourth and independent sensor i.e. one that is connected to a dive computer—to be mounted in a CCR. This adaptor is for the Inspiration and Evolution CCRs

4th sensor

Semi-closed Circuit rebreathers used to have no form of electronics whatsoever. Then divers discovered that an oxygen sensor might help them to better monitor their loop content. Some mCCRs have two cells but problems arise when on of thes cells doesn't agree with the other one. Most eCCRs come with three oxygen sensors fitted, using what is called the "Voting Logic" to double check their reading between each other (a faulty cell is voted out by the two others). Now, the idea might be to have four cells fitted to eliminate any potentia situations where two cells display wrong information but are considered to be right by the computer.

It is important for the prospective buyer to be aware of any third party testing that has been done on the product; it is of course life support equipment, so independent testing and approvals are very important. It is also a good idea to think of the company behind the product; you need to know you will be able to get spares and support in the future and be sure the product is reliable and manufactured to a standard.

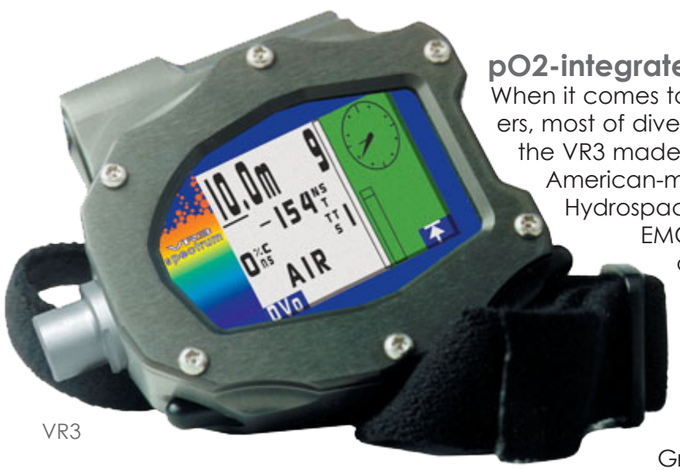
—AP Valves

Design Issues

Manufacturers tend to place the oxygen cell(s) close to the diver's inhalation in order to get the most accurate information about what the diver will actually be breathing. The loop is a dynamic environment, and its content is not the same everywhere within.

How these sensors are physically placed in the unit to ensure accurate readings of the O_2-content and avoid issues such as condensation on the sensor surface is a matter of many considerations and much dispute. Improper mixing of gases after O_2 injection may lead to incorrect readings, so does gas by pass. Also, it is a known issue that oxygen sensors read lower than normal when they get damp. Many controllers (handsets) will provide readouts from each cell so the user can somewhat diagnose their individual performances and take appropriate action in case of a malfunction. The Poseidon / CIS-Lunar is significantly different in this regard by only using one main sensor. This sensor is then repeatedly calibrated and checked against a flow of 100 percent oxygen. However, different manufacturers have different opinions regarding the design of their units.

Which way is the gas flowing inside the loop? Where is the oxygen injection located (preferably not too close to the cells to avoid oxygen spikes when an injection occurs)? Where is the diluent injection located (preferably not too far from the diver's inhalation bag to provide him/her with a quick way to get fresh and safe to breather gas)? ■



VR3

pO2-integrated computers

When it comes to constant pO_2 dive computers, most of divers immediately think about the VR3 made by Delta-P in the UK or the American-made HS Explorer made from Hydrospace Engineering, or Cochran's EMC-20H. Most of discussions on the Internet focus on these models, with sometimes strong arguments about the necessary features and advantages of one or the other. Decompression model, Graphic User Interface, reliability, customer service—it's like toppings on a pizza, everybody has an opinion about what is good or bad.

Cochran EMC-20H

What else do I need to spend on?

Air, oxygen and absorbent (soda lime) are the basic consumables. Absorbent comes in different brands, sizes and flavours. Air and oxygen doesn't.

Oxygen sensors have a limited life span and need to be changed at least every every 18 months. Batteries also need to be changed at intervals as solar cells don't perform well underwater.

Tanks

You'll also need to consider a bailout tank with a regulator fitted. It doesn't need to be a very big tank, unless you dive deep. One of the most popular bailout tanks for recreational rebreather divers is the aluminium 40cuft (5.5L), but it all depends on your open circuit gas consumption. You need to carry enough gas to safely ascend from your maximum depth and complete all your decompression, and still have some extra gas left in the tank (at least one third).

Masks and straps

Also consider some additional accessories like a neck strap or a full-face mask that help to prevent you from drowning should you fall unconscious underwater. It may sound quite unlikely, and it is, but like safely belts in a car, it save lives when accidents do occur. You don't think twice about buckling up when drive in a car, do you?

Computers

A rebreather-friendly dive computer can also help you make the most of your unit and take full advantage of the optimal mix in your breathing loop. Several dive computers on the market have a constant pO_2 capability. Some even have the option to plug in an additional oxygen sensor for real-time pO_2 calculation. But probably the most important ingredient or purchase with your rebreather is a proper training course. It is not possible to dive rebreathers safely without implementing good habits first. Rebreather diving is like horseback riding. It can be a lot of fun if you do it properly, but performed wrongly, it can also be dangerous. A rebreather is, in fact, a bit like a horse—it seems to have a life on its own. You have to stay in charge at all times in order to avoid being put at risk, which you need to be aware of.

But that's another topic…


Full-face mask

GOLEM GEAR

Recommended reading

DIRrebreather published a book written by Cedric Verdier and designed for Semi-Closed and Closed-Circuit rebreather divers. The Rebreather I book is dedicated to nitrox rebreather diving and the basic principles and skills that every rebreather diver should know and master. It covers some topics like balance and trim with a rebreather, risk management, and proper nitrox dive planning.

This book, along with other rebreather-specific books and manuals, is available on a digital format at the DIRrebreather bookshop: www.dirrebreather.com

DIRrebreather is a not-for-profit organization, and its goal is to promote safe rebreather diving. The DIRrebreather Team focuses its work on designing standard practice, equipment, techniques and procedures both for the novice and the seasoned rebreather divers. DIRrebreather divers worldwide participate in rebreather-specific workshops and DIRrebreather-sponsored expeditions on wrecks and caves. For more information, contact DIRrebreather@yahoo.com ■

So, which one is it going to be? With so many great brands and products to choose from, it can be a tough choice

PETER SYMES

Travelling with units

With the never-ending tightening of luggage allowances on flights, weight and size becomes more of a concern if you plan to bring your rebreather on a dive trip. Tanks, even the small rebreather ones, are the first items you should leave at home. Not only are they bulky and weighty, but new airline regulations stipulate that all scuba tanks should have their valves completely removed, and what that does for your oxygen cylinder is ruin the cleaning for oxygen service it has been through. Carrying a sufficient supply of scrubber also adds to bulk and weight, which might send the scales at the check-in counter in the airport well into the red zone. So, even though these consumables may cost twice the going price you are used to paying at home, at your end destination, it is worth renting tanks and buying scrubber on location. It doesn't make much of a difference on the bottom line considering the price of the whole trip. Look for 'rebreather-friendly' operators. There are usually a bunch of these at each major dive destination, and upscale live-aboards usually cater for rebreather divers, too. Some even specialised in this field. ■

O2ptima CCR neatly packed and ready to go

This is a pre-packed scrubber from Poseidon / CIS-Lunar's Discovery unit. The way airfares are heading, in the future, it will probably be far more commonplace to purchase such consumables on location rather than carrying the extra weight from home

Look for 'rebreather-friendly' operators

Tip: As tighter weight limitations on airplanes come into effect in some instances, it is sometimes a cheaper option to ship your gear ahead of you by land or surface—and less hassle, too

Other good-to-know websites

www.rebreatherworld.com
www.therebreathersite.nl
www.diveraid.com
www.DIRrebreather.com

Look for "rebreather friendly" operators when travelling with your units. It may enable you to leave lots of the heavy stuff back home and only bring the essentials

Inspiration & Evolution

Ambient Pressure Diving, United Kingdom
www.ambientpressurediving.com

Following Dräger's massive but aborted effort in the 1990s to make rebreathers commonplace on the market, Ambient Pressure Diving is the brand that saw it through. Their rebreathers with their characteristic yellow shell can now regularly be seen at many dive centers, resorts and liveaboards around the world. The various makes of Inspiration and its more compact younger sibling, Evolution, is without question the most mass-manufactured units on the market. The first make of Inspiration was marketed back in 1997, but it has undergone a steady improvement ever since. The year 2005 saw the introduction of the smaller Evolution at about two-thirds of the size of the Inspiration. This unit also introduced the advanced 'Vision' control electronics, which integrated the two handsets the classic Inspiration had into one compact unit, which also had a built-in dive computer with nitrox and trimix capabilities. Another new feature of the Vision electronics was a Head Up Display and temperature gauge on the scrubber unit. A short while later, Vision electronics were also offered for the Inspiration, so the main difference between the two was the size. Evolution uses 2-liter cylinders and a shorter scrubber unit, whereas Inspiration uses 3-liter cylinders. After the Inspiration offered advantages in scrubber duration, and the Evolution offered advantages in size and weight, a hybrid size—the Evolution+—was offered. The Evolution+ combines the 2-litre cylinders from the Evolution and the larger scrubber as used on the Inspiration—all housed in a new specially-designed case. Prices start at £ 4695 (incl VAT) ■

Isolation Valve

This little thingy goes in between your LP regulator hose and the second stage regulator/ADV. This enables you to shut off the connection in case of a free flow or other problem

Megalodon

Innerspace Systems, United States
www.customrebreathers.com

The 'Meg' is another unit that has gained quite some popularity. It is a modular design contructed around a sturdy aluminum tube, which supports the scrubber, head and cylinders. This allows for a wide range of cylinders to be used, although the standard cylinders are Luxfer aluminum 19s as well as different harnesses or backplates and wings. The single-tank adapter (STA) allows standard backplates and BCDs to be used. This makes the unit very easy to travel with, as it enables the user to bring only the essential part on trips where restrictive luggage allowances are a concern. To cater for the travellers, the manufacturer—InnerSpace Systems—has also produced a compacter version nicknamed the mini-Meg. The entire system, not including cylinders, can be packed into a hard case that will fit in an airline overhead luggage compartment. The standard scrubber is an axial design, but a radial scrubber canister is now also offered. The control unit, the electronics, consists of the head that sits in the core—which contains the O_2 sensors, electronics, batteries and solenoid—and two handsets and a head-up display mounted on the mouthpiece. Price not listed. ■

Submatrix

Submatrix, Germany
www.submatix.com

Submatix is a German manufacturer who places emphasis on ease of use, safety, easy maintenance and being uncomplicated to dive. They are also convertible and can be configured as an easy SCR system for the ambitious scuba diver as well as a demanding emCCR system for the tecnical divers. New units are being marketed in September as this magazine goes to press, so check back with the manufacturer's website. The new units have a new pO_2-monitor, 'oxyscan', and come with a newly designed case that encloses the whole unit. A new pO_2-monitor with integrated dive computer SPX 42 is expected to ship in the beginning of 2009. Prices for complete units: mCCR = € 4,800; emCCR100 SPX 42 system = from €5,000 ■

Kiss & Sport

Jetsam Technologies, Canada

www.kissrebreathers.com

'Safety in Simplicity' is the motto that greets the visitor to the manufacturer's website. The name of their rebreather stems from the well known acronym, 'Keep it Simple Stupid' (KISS). The KISS units, which come as the Classic KISS and KISS Sport, both are mCCRs that constantly feed oxygen into the loop through an orifice but also require the diver to also manually add oxygen. The monitoring displays have three independent, backlit PPO_2 displays. Each display has its own housing, battery and sensor, making the system completely redundant. The batteries are user changeable. Each display can be replaced independently, and spares are easily affordable.

Both KISS units use two individual back-mounted counterlungs, which are attached to the scrubber head from the inside of the counterlung case. The units have different canister designs. The Classic scrubber canister has an axial flow design, which holds approximately six pounds of absorbent. The gas flows down the center of the scrubber tube, and then comes up through the scrubber material where the carbon dioxide is scrubbed out. The Sport canister has a bi-axial design, which holds approximately five pounds (2.3 kg) of absorbent. The gas flows from the exhaust hose into the canister and lung below, and then passes through to the next canister and lung, and back out the inhalation hose. A variety of cylinder sizes can be used.

Kiss Classic CAD 5700
Kiss Sport CAD 4600 ■

rEVO

rEvo rebreathers, Belgium

www.revo-rebreathers.com

The main feature that sets this Belgian-made rebreather apart from the lot is the double scrubber units and independent programmable PO_2 monitors with head-up displays. The two scrubbers, being placed in sequence, are said to offer more protection against channelling as well as a better scrubber economy. The oxygen is injected via a fixed orifice with constant flow. The diver has to monitor the pO_2 and manually inject additional oxygen as needed. This unit has back-mounted counter lungs. In order to keep breathing effort to a minimum, the unit comes with a specially designed backplate, which brings the counterlung as close to the diver's body as possible. In March 2008, a new hybrid electronic rebreather was introduced. As the manufacturer states: "The Hybrid mode combines the advantages of the stable mCCR constant mass flow, with a PPO2 controller that tracks the PPO2 towards the desired setpoint." The hybrid unit is equipped with both a gas flow orifice fed by an absolute pressure regulator and a solenoid valve controlled electronically. This enables the unit to be used in any desired mode from pure mCCR up to fully electronic eCCR without the depth limitation linked to the absolute pressure used in mCCR systems.

Since the rEvo is a manually operated closed circuit rebreather, it cannot be CE certified. For this reason, the rEvo is not yet commercialised within the CE zone, but only produced for export. However, the manufacturers have informed us that they are now working towards having the electronic control version CE certified. This is estimated to happen by the end of 2009. ■

Watch out for eBay Scams

Rebreathers on eBay seem to attract a high number of scam artists. The classic tactics used by the scammers are fairly easy to spot if you look for some telltale signs:

• Hiding the identity of bidders, which prevents other eBayers from warning victims

• Requirement for buyers to be pre-qualified. Once contacted, the scammer will offer you a special deal. If they offer you an off-line deal, report them.

• A short auction time of 1-5 days, which makes it harder for eBay to spot

• Zero or low feedback

• Re-used photos and text. Have you seen it before? Is it a stock photo?

• Suspicious methods of payment that are untracable

• Wrong category. Check the seller's other listings. Does the seller have a lot of high-end stuff with similar characteristics?

• Is it an exceptionally good deal? Even on eBay: If it seems to good to be true... ■

SOURCE: **eBay**

Hammerhead

Juegensen Marine, United States

www.rebreather.us

You may say that this is a controller that has the rest of a rebreather attached to it. Juergensen Marine specializes in developing and supplying controller electronics to other rebreathers—and to the US Military—the Optima from Dive Rite to mention one. Juergensen has also produced upgrades and kits to a number of other makes. Their own rebreather has some resemblance to the Megalodon but is highly configurable. There is, for example, a choice between over-the shoulder counter lungs and backmounted counter-lungs. The scrubber is radial. The controller, which is also a full trimix computer, uses the usual three sensors for primary control, but a fourth can be added for independent monitoring by a separate computer. ■

Prism 2

Hollis Gear, United States
www.hollisgear.com

The Hollis Prism 2 is based on the ground-braking design from Steam Machines with the ongoing development aimed at improving and maturing the design for mass production. Hollis chose the Prism because it is the only commercially available unit meeting (US) military standards. The Steam machines are also unique in the way that they offer two completely different and independent systems of monitoring O_2. One system is electronic with LED displays; the other is an analogue meter that reads directly of the sensors. This allows the user to still operate the unit even in the unlikely case of a total electronic failure. The analogue meter is calibrated with a rotary switch using a simple potentiometer measuring the small currents generated by the sensors. Features include sealed electronics, radial scrubber design for lower resistive breathing effort and more efficient scrubber use and over the shoulder counterlungs for decreased work of breathing. The primary HDD (Heads-Down Display) is a battery driven sequential LED for continuous hands-free monitoring. ■

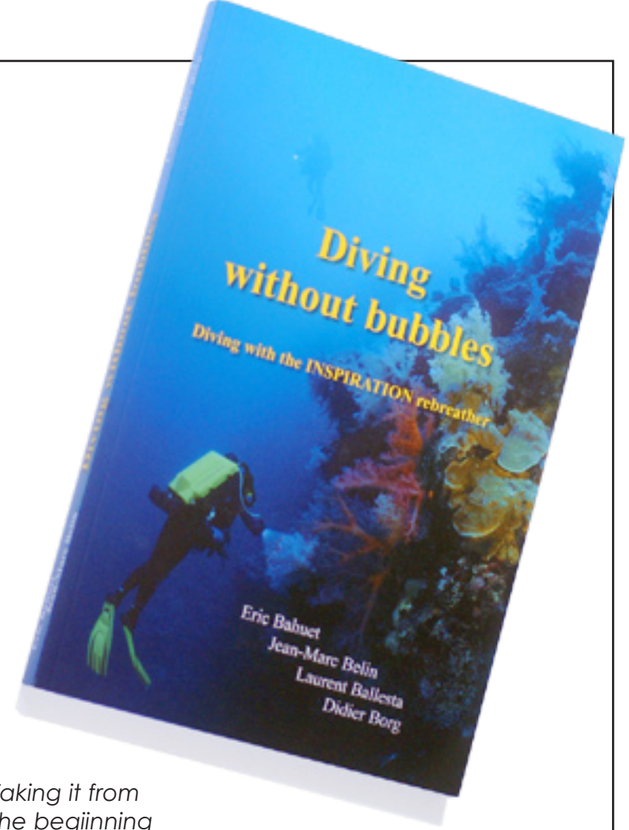
Discovery

Poseidon Diving Systems. Sweden
www.poseidon.se

When Poseidon entered the closed circuit market, they did it with a splash introducing a ground-braking first eCCR aimed specifically at sport divers rather than technical divers and packed with novel design features. The unit is very compact and priced significantly lower than mainstream CCRs closing much of the price gap to a set of open circuit equipment. Above all the manufacturer has gone to great lengths to make the unit as foolproof, user friendly and failsafe as possible. The intention is to make it as much of a don-and-dive unit for sportdivers without technical training as possible. It has also been designed with entry level training in mind. Poseidon took over the renowned CIS-Lunar brand some years ago and tied in the expertise from Bill Stone and Richard Pyle as consultants during the development, which went on for several years. The Discovery introduces many new design features and ideas. The compact control unit is completely sealed and oilfilled and cannot be accessed, or messed around with, by the user. The battery is rechargeable like a cellphone and visible from the outside where a diode shows that the battery is charged. The unit uses special scrubber canisters, so no messing around with granules or risking packing the scrubber the wrong way. The oxygen cylinder can only be filled to 100bar. This is to ensure that the scrubber always outlasts the gas. The idea is that you always change scrubber and refill oxygen in tandem, at the same time.

But what is probably to most significant deviation or development from mainstream thinking is the use of only one main sensor. The other sensor the unit carries is for the detection of internal leaks. The manufacturer explains that they have chosen going with one sensor only because the logic behind the conventional three sensor and voting logic configuration has been demonstrated to be somewhat flawed. Why focus on getting correct readings when you can rule out sensor errors? This is the philosophy. This is achieved by constantly validating the sensor against pure oxygen.

The first production units are expected to be shipped in September. ■



Taking it from the begiinning

Diving without Bubbles

This book takes a very different approach in two ways. It starts at the beginning assuming that the reader knows nothing or very little about rebreathers but is interested in the subject. This makes the book a good supplement to training manuals—there are plenty of illustrations and down-to-earth explanations. The other thing that sets this book apart is that it focuses on one product model—the Inspiration. Whilst these units are probably the best selling CCRs on the market, this will probably put off fans and manufacturers of other units from buying this book, which would be a shame, really. It does get around an amazing amount of issues and is packed with good tips and things worthwhile considering without ever getting heavy. The design does come across a little homemade in places, but so what? It's the content that matters, and the combined knowledge of the four authors—who are all leading technical divers drawing on a range of other experts—poured into this book is rock solid. ■

www.divingwithoutbubbles.com

O2ptima

DiveRite, United States
www.diverite.com

The O2ptima FX is an electonic CCR with built-in decompression ability, which has primarily been designed with diving in overhead environments in mind, such as cave diving or any technical dive where an immediate ascent to the surface is not possible. The design seeks to minimize the risk of a caustic cocktail. Two water traps in the loop along with horizontal, behind-the-head positioning of the scrubber canister, create a difficult path for water to travel, hence making it difficult for water to penetrate the canister chamber. A high impact frame and polyester cover protects the O2ptima from tight cave squeezes and rolling boats. Hoses, regulators and tanks are kept neatly streamlined and away from potential snags inside a wreck or cave. The controller is fitted with Hammerhead electronics from Juergensen Marine. The unit has over-the-shoulder counter lungs. Other standard features include Heads-up-display (HUD), Display Integrated Vibrating Alarm (DIVA), Dive Surface Valve (DSV) and Automatic Diluent Valve (ADV). The US MSRP is $7000 (cylinders are not included). ■

CE

The significance of the CE marking

In the European Union, any equipment that falls within the scope of the EU Directive on Personal Protection Equipment (PPE) must be tested and certified according the current CE standard.

In this case, the EN14143:2003 covers all rebreathers and also all PPO_2 monitors for use with a rebreather that are imported, manufactured, sold or used in work in Europe.

Any person or company that is importing, manufacturing, selling or using equipment without the CE mark can be prosecuted. Sale can be banned and goods seized, and in case of an accident involving the use of the equipment, criminal charges can be brought to the directors of the involved company.

Clearly, obtaining the approval and CE marking is a serious matter. ■

Pelagian

Rebreather Labs, Thailand
www.rebreatherlab.com

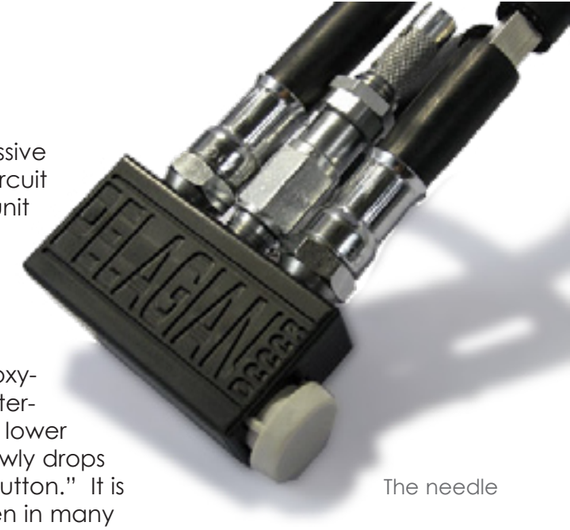
The Pelagian is deemed a DCCCR. This impressive acronym stands for Diver Controlled Closed Circuit Rebreather, which essentially means that this unit is not controlled by an automatic electronic circuit for maintaining the right oxygen-levels. In other words, it's an advanced mCCR. The oxygen is injected into the breathing loop through a valve, which the diver can vary.

Quoting the their website: "This means that oxygen is added mechanically through a fine metering needle valve at a constant flow set slightly lower than the diver's metabolic rate. As the PO_2 slowly drops the diver manually adds oxygen with a push button." It is an approach somewhat related to what is seen in many semi-closed rebreathers. But while these have a fixed orifice with a constant gas flow, in this case, the diver can fine tune the flow by adjusting the needle valve while monitoring the PO_2 on the O_2 displays.

The Pelagian Head has space for three cells sitting next to each other, which are all subject to instant cell validation. The Pelagian display shows two cells. The third cell is usually connected to a decompression computer, type Pursuit, VR3, etc. The idea is to keep the third cell completely isolated from the Pelagian display circuits so that, no matter what may happen with either the Pelagian display or the computer, none will compromise the other.

Another feature that is unique to this unit is the position of the counterlungs. They are front-mounted but also partly tucked away under the diver's arms keeping the chest area free of clutter and minimizing the work of breathing. There is no manual diluent valve but a ADV on top of the scrubber unit. Also worthwhile noting are the small dimensions and low weight of the unit, which weighs only 10.5 kg—a package small enough to fit in an overhead compartment in an airplane. It can accommodate tank sizes from 1.8 - 11 liters.

The manufacturer, Rebreather Labs, which is based in Thailand, informed us that they do not plan on getting the unit CE tested in the near future. Listed at USD 5800. ■



The needle

Halcyon RB80

Halcyon, United States
www.halcyon.net

The Halcyon RB80 is something quite unique and not a rebreather in the usual sense. It blends features and advantages from open circuit with the rebreather's capabilities of preserving gas. The name RB80 refers to the standard 80 cu ft tanks utilized by the system and its designer Rainhard Buchaly. The RB80 has been designed with reliability in mind. Adhering to the DIR principles, it is not reliant on electronics. The Halcyon rebreather supplies breathing gas as required by the diver's respiratory rate and gas replenishment is mechanically triggered by the diver's breathing cycle. The Halcyon "on demand" gas delivery system is designed to provide less oxygen variation, better predictability and overall significant performance advantages over other SCR platforms. On their website, Halcyon states that their patented technology significantly reduces oxygen content variations over a wide range of diver activity levels. Moreover, this on-demand feature is coupled with a naturally intuitive "alarm" feature, which provides the diver with an immediate and obvious indication that supply gasses are depleted or that rebreather function is somehow compromised. There is no diluent either, so in a sense, what this unit essentially does is extend the gas of an open circuit by recirculating it a number of times before exhalation. This system increases gas efficiency an average of eight times more than conventional open circuit consumption. The RB80 is offered with a dual inlet gas manifold that allows divers the ability to plug various gasses into the system, and change them during the dive as conditions and/or depth vary. or allow for the use of various bottle sizes. Divers may use any mix that would be appropriate for open circuit diving, gaining the benefit of the rebreather by greatly extending the mileage a diver would get out of the supply. ■

Ouroboros & Sentinel

Closed Circuit Research, United Kingdom
www.ccrb.co.uk

The Ouroboros is a high-end and high-performance CCR designed for the most demanding dives and divers with a long list of stringent requirements to be met. For example, it is argued that the choice of back-mounted counterlungs also allows all the soft—in the sense of being vunerable—parts of a rebreather to be tucked away under a protective shell, which makes the unit safer on wrecks full of sharp bits. Materials are resistant to corrosive agents, all cable systems being floodproof and double armoured, and so forth.

The current model is the fourth generation, since it was introduced in 2004. The unit can be used with a range of diluents from air through Trimix to Heliox. All electronic features can be overridden by using the manual functions of the unit. The unit comprises a central computer with a head-up display (HUD), a primary display for control and monitoring, and a rear facing display for buddy or instructor use. There is also an independent passive display not connected to the main electronics, which has its own power source and displays each of the three oxygen cell readings. Loss of any or all electronic displays will not stop the unit maintaining a 'life support' PO2 level.

Ouroboros

The Ouroboros is a modular design. The primary layout is a back mounted system in a hard carbon shell. Lightweight cordura covers are available with differing canister sizes as well as a chest mounted counter lung configuration.

In 2007, the smaller and more affordable Sentinel was presented, and it has just made the market. It is also fully electronic state of the art closed circuit rebreather with fully integrated decompression software, integrated bailout valve, digital HP monitor system, heads up display and a host of user selectable upgrades.

The Sentinel is competitively priced with three levels to choose from: Airdiluent(40m), Normoxic Trimix(60m) and full Trimix(100m) enabled. The counterlungs are back mounted, and where its bigger sibling has a radial scrubber, the Sentinel's is axial. ■

Ouroboros is listed at £8250 (incl. VAT)
Sentinel listings start at £4,500 (incl. VAT)

Sentinel