A Beginner's Guide to Scuba Regulators

Few pieces of sporting equipment carry more mystique than Scuba regulators; they're deemed "Life Support" by the dive gear industry, sold with a dizzying array of choices, features, and often hype, with fierce loyalty to brands common among experienced divers. In fact, scuba regulators are remarkably simple devices that do a very specific job: they reduce the air pressure in the tank to a breathable level on demand. All scuba regulators do this adequately, at all recreational diving depths and with remarkable reliability. So why all the hype? This article will break down some of the common questions, terms, and myths about regulators so that new divers can hopefully breathe easy (no pun intended!) when choosing a regulator.

1. Is a scuba regulator "Life support"?

New divers are often presented with the extremely frightening contention that their life depends on their regulator working. This is absolutely false, and unfortunately too-often used by sales staff to sell expensive regulators. It's especially ironic considering new divers have frequently taken their certification class at the very same shop! A big part of every certification class is learning how to safely deal with equipment failure, out-of-air scenarios, and diving with a reliable buddy. If someone tells you that your life depends on your regulator, don't believe it. What keeps you alive underwater is air, and any safe diver always has access to air from more than one source.

2. How do regulators work?

Basically, regulators take the high pressure air in the tank and step it down to 'ambient' pressure, which is the pressure that exists at the diver's depth. While there are a few different ways to do this, the common approach is as follows:

The first stage (the part on the tank) reduces the pressure of the air in the tank to a set pressure, called "intermediate pressure" or IP, and sends that to the 2nd stage. The way the 1st stage does this is ingenious. There are two chambers in the 1st stage, separated by a valve. This valve stays open, allowing air to pass from the tank, until the pressure in the 2nd chamber builds up to IP. Then the valve closes, holding back the much higher pressure in the tank. The air in the IP chamber beyond the valve gets sent out a hose to **the second stage** (the part in your mouth). When you use some of that air to take a breath, the IP lowers, which opens the valve in the first stage, letting more air in and restoring the IP. Pretty simple, don't you think?

The second stage also has a valve. This valve typically stays closed and separates IP air (usually around 135 PSI above the surrounding pressure) from air that's at ambient pressure, which is air we can breathe easily. The second stage 'knows' what that ambient pressure is in a very simple and effective way; there's a thin silicone diaphragm that contains the air in the second stage, separating it from the water surrounding it. When the air pressure inside the second stage equals the

water pressure outside, the diaphragm is in normal position. When you take a breath and draw air from the second stage, it allows the water pressure surrounding the diaphragm to push slightly on the diaphragm. (Imagine taking a breath from a balloon, and the balloon collapses a bit) There's a lever that contacts the diaphragm inside the second stage, and this lever, when pushed on by the diaphragm, opens the valve, allowing air to rush into the second stage and restore the diaphragm's normal position. This closes the valve until you take another breath. The simple genius of this set up is that the water pressure surrounding the diver sets up all the pressure differentials for the regulator to work. The result is that no matter what depth you're diving at (within reason) the regulator will work the same way.

3. What is a "balanced" regulator, and is it important?

There is a lot of hype and misunderstanding about the concept of 'balanced' regulators. Essentially, what this means for scuba regulators is that when a regulator is 'balanced', it tends to work more-or-less the same regardless of the air pressure in the tank. This is more important with first stages, because they have to deal with a very wide range of pressures from the tank; 3000 PSI on a full tank to under 500 PSI on a typical dive. Balanced first stages will supply the same IP to the second stage regardless of tank pressures. Unbalanced first stages, which in modern designs are always pistons, will supply a slightly lower IP as the tank empties. When combined with an unbalanced second stage, this means that as the tank approaches empty, the diver will find that breathing effort increases slightly. The key here is the word slightly; I have tested balanced vs unbalanced regulators and found that at recreational diving depths, there is very little difference in breathing resistance until the tank is well below 500 PSI. For most divers, this means you should be on the surface already. In fact, some older regulators and tank valves incorporated deliberate increases in breathing resistance as the tank emptied so that divers in the pre-SPG era would have ample warning that they were about to run out of air. Some diving practices have really changed!

One thing that's important to remember is that balanced and unbalanced regulators deal with changes in depth in exactly the same way, and for all practical purposes there is no difference in depth performance for recreational diving. It's only differences in tank pressure that affect unbalanced regulators. So if a salesman tells you that an unbalanced regulator is only acceptable for very shallow dives, don't believe it!

4. What are better, piston or diaphragm 1st stage regulators?

What a great question! You tell me, what's better, Ford or Chevy? Budweiser or Miller? Chicken or fish? The Spurs or the Lakers? (well, that one is easy!) The point is, both designs work extremely well. There are some inherent advantages to each design, but these are small and hotly contested among regulator nerds. In fact, if you ever have trouble sleeping, you might do an internet search for arguments for and

against each, and before you know it, you'll be happily snoozing. It's worked for my wife on many occasions! Here's a brief summary of each:

Piston first stages use a rigid, hollow piston, with a heavy spring, to operate the valve. The end of the piston shaft seals against a hard plastic seat, sealing the two chambers in the first stage from each other. Normally the piston is separated from the seat, allowing air to flow through the hollow shaft into the IP chamber. When IP builds up, it forces the piston against the seat, and viola! high pressure air stops flowing. The advantages of this design are simplicity, durability, and the potential for high air flow. The disadvantage is that part of the piston is by necessity exposed to surrounding water, so that in very cold conditions it can freeze open. This results in a strong freeflow, and is one reason that divers in extremely cold water often prefer diaphragm first stages. There are ways to seal the piston from water using silicone or PTFE grease, but this adds expense to servicing the regulator.

Diaphragm first stages use a thick rubber diaphragm, with a heavy spring, to operate the valve. This involves a slightly more complex design, as there needs to be a pin, some other parts, and another smaller spring to connect the diaphragm with the valve. There are a few more parts to replace at servicing, and the potential air flow is not as high as with the highest performance piston first stages. However, an advantage is that most of the working parts of the regulator are sealed from water. Diaphragm first stages typically are more freeze resistant and a little easier to keep clean from salt water corrosion. One of the classic diaphragm first stage designs has been around for several decades, almost unchanged since the days of the old double hose regulators. Jacques Cousteau used these on thousands of very deep, very demanding dives. Remember this when a salesman tries to convince you that only the latest and greatest regulator design is good enough for you!

5. How often should I service my regulator?

For many years, the big regulator manufacturers insisted that their products be serviced annually, at an authorized dealer, for the warranty to stay valid. This gets expensive, even with the 'free' parts promotions many manufacturers offered. More recently, some companies have switched to two years between servicing, sometimes with annual inspections. This is not because regulators have magically become twice as durable; it's due to competition between brands, which is quite fierce.

There is a myth that contends that, even in storage, regulator soft parts, mostly rubber o-rings, degrade quickly enough so that they should be replaced annually. If this were true, regulators would be failing all the time, divers would be panicking with every dive, and we'd all just switch to golf. How depressing is that! The truth is that with normal use and adequate care, most regulators will work fine for many, many dives, almost always over 100 dives, and sometimes quite a bit more. It's surprisingly easy to inspect your own regulator and get some idea of how it's working, with simply a scuba tank, a vessel of water (like your tub) and a simple IP gauge that connects to your BC inflator hose. It's beyond the scope of this article to

describe an inspection routine, but it's easy to find this information on some of the better known scuba internet discussion boards or even from a knowledgeable and friendly regulator technician. There's also an excellent book, Vance Harlow's *Scuba Regulator Maintenance and Repair*, that has a chapter on inspecting your regulator. Once you can confidently inspect your regulator, you'll be able to spot indications that it's in need of a service; maybe the IP is creeping up, maybe there's a small leak at the second stage valve, or maybe you just haven't had it in for a long time and would feel better; the point is that it's absolutely possible to be informed and in control when it comes to deciding about regulator servicing.

There are two important caveats: **One**, it is very important to care for your regulator correctly. You must make sure any salt water gets rinsed completely off the regulator before storage. I soak my regulator in clean fresh water for a couple of hours after every salt water dive. This allows the salt to migrate from the threads and any exposed part of the regulator. Make sure you either have the dust cap firmly in place on the first stage, or better yet, attach the regulator to a tank and pressurize, before you soak it. You don't want any water to get into the first stage. **Two,** if you bought your regulator new and want to keep the warranty, you must follow the manufacturer's requirements for service.

Finally, when shopping for a regulator, please try to relax and enjoy the process, as it's tough to find a sub-par regulator these days. Remember that every day, many thousands of people dive safely on all types of regulators at all price levels. Diving is a great, fun activity regardless of the regulator you choose.

About the author:

Kobay Ashi-Maru is an avid diver and regulator nerd who has rebuilt many vintage regulators and currently maintains an ever-growing collection of older Scubapro and US Divers regulators. He's also an award winning musician and is involved with Australian Shepherd rescue in central Texas. He lives in San Antonio, but has no plans to dive the famous riverwalk.