The Isolation Manifold

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Introduction

This article is an explanation of the isolation manifold diving system. I aim to introduce the uninitiated to the concepts involved and provide information so that current users may become more familiar with their chosen system. If you dive with a manifold or if you dive with a person that utilises one, you should have a thorough understanding of the mechanical workings. If a diver does not fully understand the complexities incidents are far more likely to occur.

History

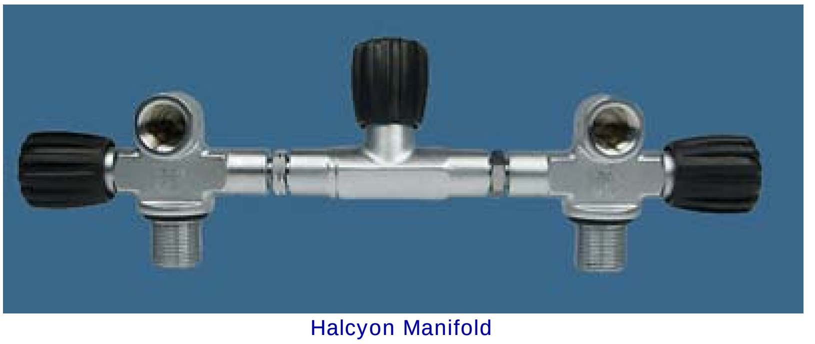
In the early 1970's Canadian, George Benjamin saw the need to make a simpler system to assist him with his deep diving endeavours amongst the blue holes in the Bahamas. Utilising a machining shop he and Ike Ikehara produced a manifold block, which enabled both tanks to be connected together and gas to be breathed from two posts. This became known as the 'Benjamin crossover manifold' and marketed commercially in the United States as an isolation manifold. There are now two common types, the barrel O-ring and the captured O-ring. Captured O-rings are fundamentally less solid. Any twisting of the tanks potentially can break the face seal causing a loss of gas. Barrel o-ring manifolds utilise a male fitting containing 2 barrel o-rings which fit into a female fitting tank valve, which is far more secure.

Mechanics

Whilst utilising a manifold any leak or failure of a regulator can be addressed simply by shutting down that offending valve. Gas from that tank can still be breathed via the second regulator on the other post. Therefore any one failure is less serious as a diver still has access to the entire gas carried. In the unlikely event that a tank neck o-ring or burst disk ruptures the isolator valve can be closed saving one half of the divers' gas. Ideally a diver should continue breathing gas from the leaking tank until it is drained.

If directly facing an individual valve on a manifold, they each turn off clockwise. That is, turn to the right to close. This quickly identifies the obvious issue as the left post, which can roll shut during the motion of swimming forward (by rolling to its right). This is less than ideal and users of a manifold system should be very familiar with this hindrance. To achieve a closed valve it requires approximately 4 full turns of the knob. This problem can be created on a left post by rubbing or rolling the valve against the roof and travelling forwards. Similarly divers should be aware that the right post can roll shut if you were to travel backwards and rub the valve against the roof.

The initial action drill/response to this dilemma is for a diver each time they feel their valves touch anything, they conduct a valve check to ensure each valve is open. This is now taught within the CDAA training system. It requires the diver to check each valve of the manifold starting from the right valve to the isolator and finally to the left valve ensuring each is"on." This simple drill conducted regularly, will almost certainly ensure that a closed manifold never becomes a problem. If a diver during a dive discovers a closed left post inevitably he/she has not bothered to check their valves regularly during the dive.



Halcyon Manifold

Manifold Management (preventative)

- Valve check - right post/isolator/left post (right to left) at commencement of the dive,
- Valve check right to left if you touch any part of the cave,
- Valve check right to left at gas turn point in the dive,
- Valve check any time you are uncertain of their current status.

Configuration

Having identified the weakness of an isolation manifold as the left post rolling shut, a diver should consider what hose is the most important in his system. Without a doubt, it is the hose you are primarily breathing, enabling you to survive the underwater environment. To this end it makes sense that this hose be placed on your right post where it cannot roll off. The second most important hose in the system is your primary buoyancy inflation hose. This also is placed on your right post as you do not want to have either breathing or buoyancy issues at a critical moment.

Now, logically to keep systems redundant, your back up regulator should run from your alternate first stage on the left post and your redundant inflation system (your drysuit) should be connected to the left post as well. This enables a diver during a failure of either post to have an air supply and a buoyancy system to exit the cave safely. In my opinion there can be no argument to this sound logic.

The remaining hose attached to a manifolded system is a high pressure SPG. Being manifolded together we require only one SPG. Unlike independent systems, which must keep track of both tanks, a manifold enables one gauge to read both cylinders pressure at one time. If the SPG fails the dive is turned. If you are diving within your gas rules there is no necessity to know your exact pressure during an emergency exit. You must have been within 1/3rds and are now on your way out. Your buddy's pressure gauge can also acts as a reference. Divers should also be aware of their buddies breathing capacity as a reference to their own.

We place our SPG on the left post for two reasons. Firstly, if the left post rolls closed the SPG is an indicator to a diver of this fact. The pressure gauge will read either very full or very empty. Very full because you are recording only the line pressure in the left post 1st stage, which has not changed since the commencement of the dive or very empty as you utilise the air in the hose to inflate your drysuit or the backup regulator purges. This pressure in the line may therefore drop to empty very rapidly but will not be consistent with your depth and time for your dive. Secondly it keeps the right post clear and enables a similar routing of the 2m long hose without the complexities of having a clipped off SPG to manage during hose donation.

Strengths

Manifolded cylinders are undoubtedly the easiest to streamline as far as hose configuration is concerned. They require one less hose which is effectively one less possible failure point in a system. They are simpler to monitor and control your gas usage due to the non-requirement to swap regulators. Gas management and calculations are simpler and enable a diver to utilise the 1/2 plus 15 bar rule in utilising multiple stage bottles. The lack of all these complications make the manifold ideal for deep diving where mental calculations are more prohibitive.

If a failure is to occur statistically manifold systems are more likely to enable a diver to exit whilst still accessing all available gas. Any single failure in an independent system renders the offending cylinder totally unusable. Independent divers can then only exit on the gas in their working cylinder.

Weaknesses

Just to rattle some of the manifold advocates, you must be aware that there is actually a possibility of a total gas loss. In the circumstance where your isolator valve knob were to shatter and a leak to commence from the isolation valve itself or from barrel O-rings of the manifold T-piece you risk total gas loss as you could not close the valve due to the shattered knob. This is a single point failure and most dangerous. In an effort to reduce this likelihood rubber knobs are recommended as they are less likely to shatter rendering the valve useless and unable to be manipulated. Isolation T-pieces are also not locked off, enabling them to rotate slightly and have some give in the knob if smashed hard against the cave.

Another negative issue is the potential to breathe a dangerous gas due to an incorrect filling process. If a dive shop were to undertake to give you a Nitrox 32 fill and after putting the oxygen into your cylinders, decide to close your isolator just in case the gas leaked over night. The gas mixer returns the next day and with the isolator closed air tops from the left post you would leave the shop with 35 bar of oxygen in your right tank and 230 bar of Nitrox 32 in your left cylinder. Your SPG would show 230 bar analyse correct from the left post and appear OK. If however you were to breathe from your long hose (right post) you would be breathing pure oxygen risking oxygen toxicity poisoning or death.

Due to this potential issue, always check your valves are open prior to filling, diving and analysis and habitually analyse and fill your cylinders from your right post.

Problem solving

Lack of understanding of the mechanics of a manifold leads to ineffective problem solving of what certain information indicates.

For example: *You are ten minutes into a dive at a depth of a constant 10 metres. Your starting pressure was 240 bar :*

- *Your SPG now reads 40 bar - this indicates immediately your left post is closed and you have diminished the line pressure.*
- *Your SPG reads 240 bar - this indicates immediately your isolator is closed as you are breathing gas only from the right tank.*

Both these problems quickly identified are easily remedied. Stop think and act. Then communicate to your buddy. Have them confirm that the issue is corrected, continue or call the dive. To this end I find it imperative that the divers I dive with have the same understanding of my system as I do. They can act in a pre-determined sequence to efficiently and quickly fix an issue before it compounds. This standardisation, I suggest should be adopted by all divers whatever their personnel diving configuration.

Managing a real failure

If during a dive, a regulator, valve or hose fails, a diver should immediately try to identify which post is the cause of the issue and close the connecting valve. The diver must be instinctively aware as to what closing the valve will effect within his diving system. For instance, if you identify it as the right post failure you must understand closing it will shut of the regulator in your mouth and you will not have gas, nor will you have BC buoyancy. You must shut the valve and swap regulators in this scenario.

Once the offending valve is closed attempt to fix the problem, communicate with your buddy and either continue or call the dive. If you can not immediately identify the problem yourself and having shut down the valve you thought was defective, you should then isolate the isolator immediately maintaining at least half of your gas supply. Then communicate with your buddy. Your buddy is in a far better position to assess the situation and identify the problem. He can visually rather than tactilely address the problem.

This now highlights why a dive buddy should be familiar with your configuration, ideally the same as his. A buddy needs to first see what hose you are breathing and check what valves are on and what are closed. This moment may be critical as if he/she does not understand your hose setup, things are going to get 'mind focusing' fast, when he/she then shuts off your remaining post! The buddy can address your problem determine whether it is fixable then and there, or not, take required remedial action and then either call the dive or indicate he has fixed the issue. The diver should then verify what has been done to his system by checking his valves right to left noting if any are not operational. Being able to instinctively identify what the closure of each valve means to your system is crucial at this point.

Conclusion

It is essential all divers are instinctively aware of how a manifold system works mechanically and what is affected by closing any valve. Both divers should be wholly aware of exactly what state the damaged divers' valves and therefore what equipment functionality is all times.

Practise valves drills. Become comfortable shutting down all valves in a controlled sequence and learn what the closure of each valve will affect.

Lastly, I have commonly seen independent cylinders configured with a manifold system left post on their left cylinder. Users need to understand; although this is both more aesthetic and easily manipulated you are in effect getting the absolute worst of both worlds. You now have system that has the weakness of the manifold system - left valve roll off, but do not have a manifolder's benefit of being able to access that gas.