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Practical Argon

Argon Suit Inflation System

It is simple to build an argon suit inflation system from a regulator first stage and a pony bottle. As shown in Figure 1, a pressure relief valve should be installed one of the regulator's low-pressure ports. Tune the valve to release gas at less than 200 psi (13 bar). Then, if the first stage freezes, or the high pressure seat fails, the low pressure side of the regulator will not creep into high pressure service, resulting in a burst inflation hose --at least.

As a back-up inflator on an air or nitrox dive, the low-pressure hose from the diver's buoyancy compensator should be detachable and able to reach the dry suit's inflation port. The addition of a low-pressure hose to a nitrox stage could work for a back-up on a trimix dive, but this increases system complexity.

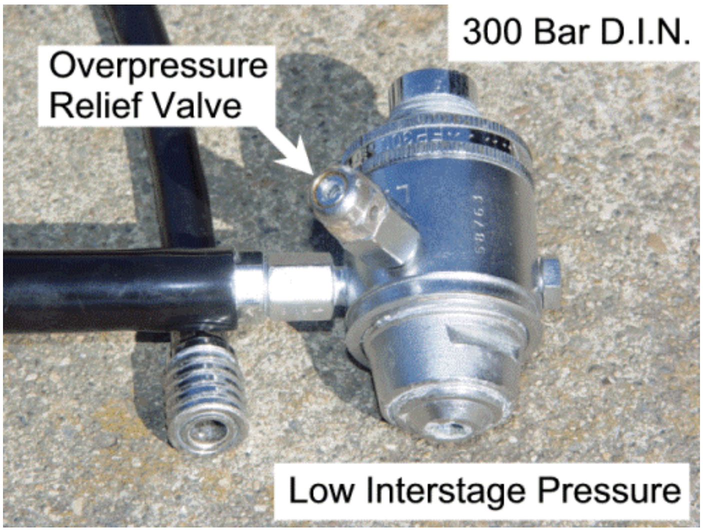

Figure 1 Argon regulator made from an unbalanced diaphragm style first stage. An overpressure relief valve, tuned by adjusting the load spring with a hex wrench, is installed on one low pressure port.

Hardware for Argon Fills

While argon fills are available at many technical facilities, they can easily be done as a transfill from an industrial cylinder to a pony bottle with a gas transfer whip.

Common inflation tanks that are used in the US range from 4 to 14 cubic feet volume of compressed gas (1 ft^3 = 28.3 Liters) and 2015 psi to 3000 psi working pressures (14.7 psi = 1 Bar). Small tanks help streamlining, but they require a booster to fill completely. On the other hand, relatively large low pressure tanks can support multiple dives on a transfill at even a few 100-psi (or 10s-of-Bar).

If you contemplate the number of pre-filled small suit inflation bottles that would be required to support an extended dive trip, this will encourage

DIY style self-sufficiency. Figure 2 shows a photo of a gas transfer whip that I made from old regulator parts, and hardware from McMaster-Carr. Airspeed Press has good references to help you set up your own fill capabilities.

The North American CGA #580 fittings for industrial argon cylinders are the same as other important inert diving gases (including He, Ne, and N_2). Figure 3 shows interchangeable SCUBA, CGA, and pipe fittings that can be used to move gas with a gas transfer whip. For world-travelers, the common denominator in high pressure gas fittings are the *US National Pipe Thread* (NPT), and *British Standard Taper* (BST). As long as you have adaptors to these threads, local gas bottle fittings can be attached to your gear.

Apart from a LDS with a well-stocked diving gas station, welding shops are a traveling gas diver's best friend. With some planning, it is easy to arrange to pick up argon and other gasses -- even in remote areas. Make sure that in addition to specifying the gas that you want, that you also note the valve threads --this will help avoid mix-ups, where, for example, you might be mistakenly given welder's Argon/CO_2. If you travel without a booster, it's best to take the entire supply cylinder to the fill site.

Some of the other suit inflation candidates considered in the article *Why Argon?* require fittings that are not commonly available. Nonetheless, for completeness, we'll consider less practical gases, such as carbon dioxide and sulfur hexafluoride, which are supplied in a liquefied form. There are efficient ways to transfer liquefied gases from cylinder to cylinder, involving heaters and snorkels, however, most divers would prefer to rely on a simple gas transfer hose. If you did use a fill whip to transfer gas from a liquefied source to a suit inflation bottle, the process would be slow and pressure in the suit bottle would be few hundred psi (10s of Bar) --at most. Even if you could transfer liquefied gas to your inflation bottle, the possibility of shooting liquid into your suit should discourage you from doing this. In an extreme case, the high pressures and low temperatures at depths in excess of 500 ft (150 m) could also cause a number of problems with SF_6. The gas in the diver's suit would tend to revert to liquid, and the equilibrium vapor pressure of the gas over liquid in the inflation bottle would not be

Figure 2 A pressure gauge, coupled to a standard industrial pneumatic fitting, is used to adjust the inflation regulator's interstage pressure and also the pressure relief valve's blow-off pressure. Other fittings are shown as examples of other convenient utilities that can be hooked-up to SCUBA for purposes such as lift bag inflation, or driving a booster pump.

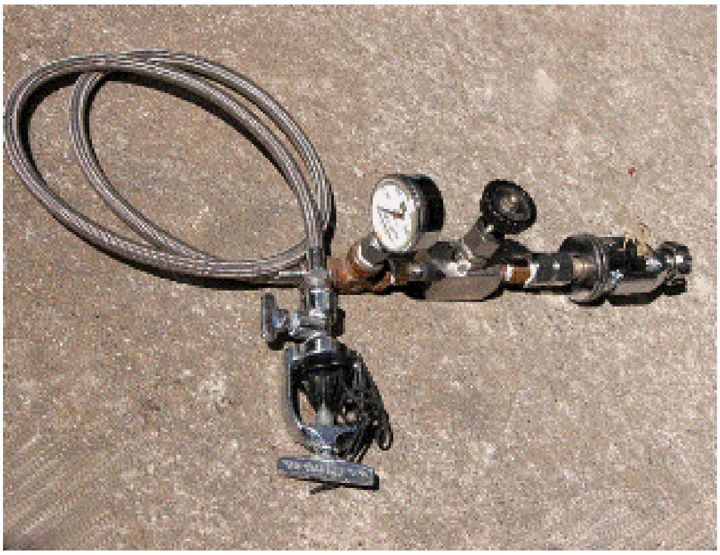

Figure 3 DIY O_2-Clean gas transfer whip. Stainless steel fittings are used for components that are changed frequently.

sufficient to build interstage pressure for delivery through a regulator.

Rigging

There are many options for placement of the inflation gas bottle. Rigging as a stage, or attached upside down to the back plate are likely the cleanest configurations that allow easy access to the valve. Figure 5 shows a tank mounted configuration, which is suitable for large pony bottles that can hold enough gas for many dives.

Alternatively, military swimmers incorporate inflation gas into the diver's dress independent of the UBA by placing a small gas tank into a pocket on the diver's hip. This configuration may be impractical for drysuits with hip utility pockets.

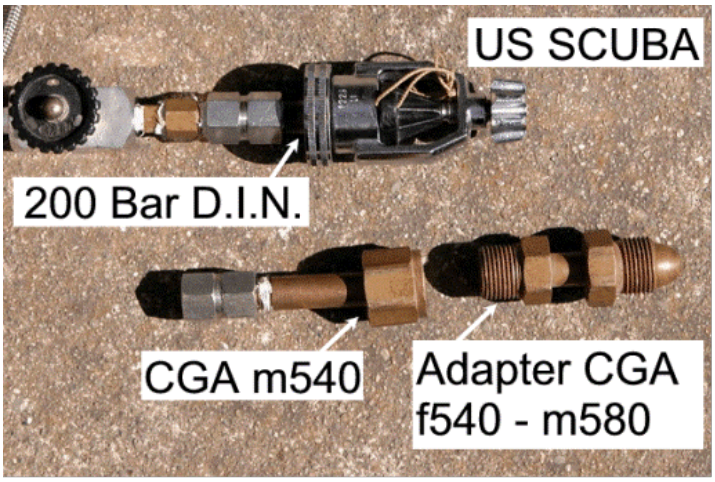

Figure 4 Interchangeable CGA and SCUBA fittings at the end of a gas transfer whip

Safety

User vigilance is essential to minimize the risk of tragically mistaking inflation gas for breathing media (Reference 4). Figure 6 illustrates a label that identifies the cylinder contents as argon, which is not suitable for breathing.

Another safety issue arises if the diver is using a helmet or full-face mask with a dry hood or neck dam above a dry suit inflated with argon. If argon leaks above the neck seal, into the diver's oral/nasal, then narcosis or asphyxiation could result from inspired argon.

There are a number of safety advantages associated with attaching a suit inflation bottle directly to the drysuit. Principally that suit inflation gas stays with the diver, rather than with the harness. This preserves inflation capability for cases when a diver doffs their tanks on the surface to expedite boarding a vessel. Additionally, if the need for in-water recompression arises, then the afflicted diver can reenter the water with a harness for therapy stages without struggling to don a full set.

Figure 5 A large tank-mounted pony bottle is not as streamlined as a small bottle fixed to the back plate. Nonetheless, one fill supports multiple dives and even a very low pressure partial fill will be adequate for a long decompression dive.

Operations

Prior to diving, residual atmospheric air should be purged by inflating and venting the dry suit a few times with argon to eliminate comparatively high conductivity air and water vapor. For shallow dives, purging by a couple full inflations and dumps is particularly important for insuring that your suit is actually inflated with nearly 100% argon.

In contrast to surface preparation, venting suit gas during a dive actively transports heat away from the diver. While you need to vent gas that expands during a controlled ascent, remember to tighten the suit dump valve a bit for decompression stops to avoid accidental loss of warm gas. Not only does warmed gas leaving your suit take away heat, the energy required to warm any replacement gas could have been better used somewhere else.

Water vapor from perspiration will condense in the undergarment, increasing the fabric's conductivity and diver heat loss. Steps should be taken to minimize perspiration, or a vapor barrier should be employed between the diver and the insulating undergarments.

Figure 6 Clear tank markings, dedicated tank service, repeated analysis of gas composition and pressures are all key components for enhancing the safety of mixed gas diving.