

Composite Scuba Cylinders

By Francois Burman and Mark Gresham

COMPOSITE, FIBER-WOUND CYLINDERS ARE MAKING THEIR WAY BACK into diving in rebreathers and other advanced scuba gear. The weight and lifespan benefits of these cylinders are attempting to challenge their previous cost barrier. For this DAN update on the technology, we spoke to a well-known industry expert in cylinder inspection and maintenance.

Francois Burman: How has composite cylinder use changed since the early days, given the reported problems with scuba after immersion, especially in seawater?

Mark Gresham: Fifteen years ago there was a Type 3 (aluminum-lined) cylinder that had corroded underneath the carbon due to saltwater intrusion between the fabric and the aluminum liner. The manufacturer cut open the cylinder to assess the corrosion, and within hours they posted a policy disallowing their Type 3 cylinder for diving.

The cylinder manufacturer's DOT Special Permit (SP) started including this prohibition, and although the National Fire Protection Association (NFPA) allows them for quick rescues of people in submerged cars near the surface, the postrescue gear cleaning required the cylinder to be discarded.

A few Type 3 cylinders are allowed for use in water, such as the one with SP number 12479. Cylinders marked UW to ISO 11119-3 are allowed for use underwater. Once permitted, Type 4 (polymer-lined) cylinders will be more suitable for scuba.

What are these cylinders' limitations?

Several have ruptured from overfilling, physical damage, chemical exposure, or being filled while having unseen damage.

One rupture was a direct result of cleaning the cylinder with acetone, which melted the epoxies used in its manufacture. When the acetone-cleaned cylinder was filled, it failed before



Some Type 3 (aluminum-lined) cylinders are allowed for use in water, but Type 4 (polymer-lined) cylinders are much more suitable for scuba. If either of these composite cylinders are to be used in water, there are many pros and cons to consider.

getting to the service pressure of 4,500 psi. Therefore it is essential to follow the manufacturer's guidelines for care of any gear.

How robust and durable are they?

Most solid-wall steel and aluminum cylinders are designed to rupture at 2.3 to 2.5 times the service pressure. Type 3 carbon overwrapped cylinders are designed to rupture at 3.3 to 3.5 times the service pressure. These composite cylinders are vulnerable to damage such as abrasions or cuts, but a formally trained technician may be able to repair some types of damage.

How does the cost compare to a traditional solid-wall and not metal cylinder?

A well-maintained solid-wall scuba cylinder can last more than 50 years, but most composite cylinders have a significantly shorter specified lifespan, potentially only a few years. The price difference between equal volume solid-wall and composite cylinders can be three to five times more.

Do these cylinders need to be filled more slowly?

The filling rates of all cylinders are often argued over in the scuba industry. The NFPA standard is 300 to 600 psi per minute. This rate mitigates the heat of compression, which reduces the temperature gradient between the cylinder gas temperature and the ambient temperature. Therefore, the cylinder does not require additional gas or overfilling for the fill to end at the rated service pressure as there is very little cooling.

How often do they need to be inspected and tested?

Most Type 3 cylinders are inspected and tested at standard requalification (hydrostatic testing) periods, typically every five years. Visual inspections of Type 4 cylinders are required annually, with requalification required every five years. Inspectors with regular formal training can perform the tests on Type 3 cylinders, but Type 4 cylinders have additional documents and requirements.



Given the high cost of composite cylinders, it is unlikely the dive community will widely accept them.

What are some situations where it makes sense to use a composite fiber cylinder?

When neutral buoyancy is required, these cylinders can be helpful when well-balanced with an internal bladder and additional weights if required.

The most common Type 3 cylinders are approximately 13 pounds (5.9 kilograms) buoyant when full, which makes them a poor choice for diving. The positive buoyancy would require additional weight, potentially making it difficult to address entanglements or hazards that require a diver to remove their kit, causing significant changes in buoyancy.

Are these cylinders suitable for other breathing gas mixes? Do they have any gas content limitations?

Type 3 composite cylinders are manufactured for use with the most common breathing gases used in sport diving. The notable exclusion is the prohibition in Title 49 of the Code of Federal Regulations, which states that pressure may not exceed 3,000 psi when filling with oxygen.

Divers should always refer to the cylinder's DOT Special Permit to verify the types of gas they can use in

the cylinder. The cylinder's placard may also specify the types of gases acceptable. In that case, the cylinder must only be filled with the gas listed on the placard.

Considering all the above, is a composite fiber cylinder worth the expense?

Not at this time. Composite cylinders have been in use since 1942, mostly with limited applications in aerospace and defense. These cylinders have always been costly compared with solid-wall steel and aluminum cylinders.

Advances in material sciences have broadened potential uses of composite cylinders, including suitability for use underwater. Composite cylinders are finding their way into scuba breathing systems. Prices may decrease as more uses are identified and they are produced in larger numbers, but they are still unlikely to approach the widespread use of standard steel and aluminum cylinders. Considering their substantially higher pricing, it is unlikely that the dive community will widely accept the return on investment. AD