Cylinders – All you wanted to know…….

Contents

Purpose

- To store compressed gases to breathe.

Materials

- Steel
    - Steel cylinders (right of picture) are made by drawing and spinning and are 4-5mm thick.
    - They are usually galvanised prior to painting.
    - Steel cylinders have a rounded bottom and require a cylinder boot to enable them to be stood upright.
    - Steel tanks normally change from substantially negatively to slightly negatively buoyant between full and empty. Some weight MAY be taken off the weighbelt to compensate.
    - Steel tanks are more prone to test failure due to corrosion as they suffer from a progressive 'rusting' process
- Aluminium
    - Aluminium alloy (left) is made by extrusion and forming. They are not as strong as steel and therefore require an 11mm wall thickness.
    - Aluminium cylinders are anodised prior to painting and, as they are also affected by oxidisation which results in the formation of a coating, they do not corrode as much as steel.

    - Aluminium cylinders are easily identified by their flat bottom.
    - Aluminium cylinders are normally more bulky and heavier than a like capacity steel cylinder.
    - Aluminium tanks will change from slightly negatively to positively buoyant between full and empty, therefore more weight on the weightbelt may be needed to compensate
    - Aluminium is a softer material than steel and, consequently, is more prone to superficial damage
    - Cylinder valves, which are normally made of brass, can corrode into the aluminium, due to electrolytic action. This can cause seizure of the valve in the cylinder threads unless it is periodically removed and cleaned
- Carbon Fibre compounds (NOT used for diving)

Sizes

- 3, 7, 10, 12, 15 litres
- Other sizes available but are not as common.

Working Pressures

- Old: 200, 207, 228 Bar
- Modern: 232, 300 bar

Markings

- WP
    - Working Pressure – should not be filled to any greater pressure unless under test.
- TP
    - Test Pressure – the maximum pressure that the cylinder is tested to
- WC
    - Water Capacity – the internal volume of the cylinder measured in litres
- Manufacture Date
    - Manufacturing date (Month/Year) – used for the timing of Periodic tests. Even if a cylinder is bought 6 months after manufacture, it is the manufacturing date, and not the date of purchase which is used for the first, and subsequent, periodic tests.
- Mark
    - Manufacturers Mark
- Standard
    - Pre July 2002 cylinders will be manufactured to, and marked with, the relevant British Standard – BS5430/1 for Steel cylinders and BS5430/3 for Aluminium cylinders. Since September 2002, a new European Standard for manufacturing came into effect. The new standards are EN1968:2002 for Steel cylinders and EN1802:2002 for Aluminium cylinders.
- Test Date
    - This will only appear once a cylinder has been subjected to a periodic test. Prior to September 2002 the test date was stamped as the month/year (i.e. 08/02) of the test. Cylinders tested since September 2002 will be stamped with the year/month (i.e. 2002/09) of the test.
- Thread Size
    - This is the size of the thread in the cylinder neck. This enables the correct cylinder valve to be fitted.

- Weight
    - The dry weight of the cylinder, when new. This is used during the periodic test. If the cylinder loses 5%, or more, of its initial weight due to internal shot-blasting, then the cylinder will fail the test.

Periodic Inspections

- Visual Test
    - Under the new European EN standards, a visual test is required every 2½ years. The test period runs from either the date of manufacture or the date of the last hydrostatic test.
    - Essentially this test is a detailed visual inspection, both internal and external with the following failure criteria:
        - Bulge - all fail
        - Dent - fail if any greater than 2 mm
        - Wear - reduction of wall thickness greater than 25%
        - General Corrosion - reduction of wall thickness greater than 20% OR where original surface is not visible
        - Area Corrosion - (i.e. where corrosion is limited to less than 20% of surface) a reduction of wall thickness greater than 25%
        - Isolated pitting - Reduction of wall thickness greater than 40%
        - Thread damage - all physical damage or imperfections (re-cutting of threads can be achieved up to a maximum tolerance)
        - Weight Check - Weight of cylinder (minus valve) less than 95% of the tare weight stamped on the cylinder
    - Where a cylinder has internal corrosion, it will be internally shot-blasted to remove the rust to enable the visual inspection to be carried out. The new European EN standards are much stricter on the amount of internal corrosion allowed before shot-blasting is required. It is therefore likely, that more cylinders will require shot-blasting at an additional cost of between £10 - £15 per cylinder.
    - Any cylinder that has been subject to impact damage should be pressure tested before use. If in the opinion of the inspector, any of the above criteria are borderline, then hydrostatic testing may also be required.
    - Failed cylinders will generally be cut in half or returned to the customer in such a state that makes the cylinder unusable.
    - The typical cost of a Periodic Visual Inspection is between £15 - £20 per cylinder.

- Hydrostatic (or hydraulic) Test
    - Under the new European EN standards, a hydrostatic test is required every 5 years. The test period runs from either the date of manufacture or the date of the last hydraulic test.
    - The Hydrostatic test also includes a visual inspection as detailed above.
    - For the Hydrostatic test, the cylinder is filled with water and then placed inside a water-filled, high-pressure chamber. The water pressure inside the cylinder is then increased to five thirds of it's maximum working pressure. This is sufficient to cause the cylinder to expand slightly. This expansion causes the water outside the tank to be displaced and this is channelled into marked collection tubes that allow it to be measured. If the tank's expansion is within acceptable limits (< 5%), it successfully passes the test. If not, the tank may not be refilled.
    - After pressure testing, tanks that pass are cleaned and dried, then stamped with the current month and year and the tester's initials.
    - Failed cylinders will generally be cut in half or returned to the customer in such a state that makes the cylinder unusable.
    - The typical cost of a Periodic Hydrostatic Test is between £20 - £25 per cylinder.

- Test Certificate

    - Centres and shops should now ensure that the paper test certificates issued with a tested cylinder bear the name of the cylinder's owner, not just whoever dropped it off for testing.

- Mini Cylinders
    - Cylinders of 0.5 litres or less are NOT covered by the new standards. These will still be tested to the old standards (BS 5430 part 6) with the test intervals of 2 and 4 years.

Protection

- Mesh
    - Prevents scratches and damage to the exterior paintwork.
    - Try to ensure that it is fitted within the cylinder boot to keep it securely in place.
- Boots
    - Required on all Steel cylinders as their bases are rounded.
    - Not required on Aluminium cylinders as the base is flat.
    - Protects the base, and paintwork, of the cylinder (steel or aluminium)
    - Enables the cylinder to be stood upright (steel)
    - Made from Rubber or PVC
    - Make sure that when cleaning a cylinder after use, water is washed around, and inside the boot
    - Periodically remove the boot for thorough cleaning and to check the paintwork for bubbling or cracking and subsequent rusting.
- Carrying Handle (This puts less stress on the neck threads)

Labelling

The Carriage of Dangerous Goods Regulations (1996) requires that cylinders are either correctly labelled with their contents OR that they are painted in the approved scheme (i.e. for compressed air and nitrox this means that black and white quarters are painted on the shoulder).

Since the introduction of the new European EN standards for periodic cylinder testing in September 2002, another new European standard came into force (EN1089) which covers cylinder test stamp marking, (see note above), precautionary labels and colour coding. This new standard applies to all cylinders being tested to the new European EN standards.

- Intended Contents Marking
    - The intended contents may fall into one of three categories – Breathing Air, Nitrox or Trimix. The marking must also include a green warning triangle. This regulation is easily

overcome by the application of a cylinder sticker. This need only be minimal in size - it only needs to be big enough to contain the required information, which can be easily seen and checked by the cylinder filler.
    - Note that the sticker only describes the INTENDED cylinder contents - the cylinder may NOT necessarily actually contain the gases described (i.e. a Nitrox cylinder may contain Air).
- Re-Test Date Marking
    - In addition to stamping the cylinder with the test date, it is mandatory to mark the cylinder with a punch-out sticker to make it easy to see when the cylinder is next due for test.
- O2 Service Date
    - This sticker indicates the date when the cylinder was last O2 cleaned. This will be checked prior to Nitrox filling. O2 cleaning should be carried out annually. Filling operators may refuse to fill a cylinder with Nitrox if it has not been cleaned in the previous 12 months.
- Mix O2%
    - This label should be affixed (or amended) by the filling operator, to indicate the Oxygen percentage of the gas mix in the cylinder at the time of filling.
- Mix He%
    - This label should be affixed (or amended) by the filling operator, to indicate the Helium percentage of the gas mix in the cylinder at the time of filling.
- MOD
    - This label should be completed by the diver after the gas has been analysed.
- Exterior Painting
    - Until the new European EN standards came into effect in September 2002, there was no restriction on the colour of cylinders , provided that the cylinder complied with the Carriage of Dangerous Goods Regulations (1996). However, since the introduction of the new European EN standards in September 2002, if the cylinder is being tested to the new standards, then it should comply fully with all applicable standards. Therefore all diving cylinders should be painted with black and white neck quartering. The body of the cylinder may be painted in any colour

Twinsets

- A Twinset is the term given to the coupling of two cylinders, usually of equal size and weight.

- A Twinset may consist of either :
    - Two coupled cylinders with independent valves and regulators, or
    - Two coupled cylinders where the cylinder valves are specifically adapted to enable a manifold to link the two valves, and therefore air sources, together.
- Twinset cylinders are coupled by either using a double boot, stainless steel cylinder bands or a combination of both.
- Independent cylinders ensure that in a free-flow situation, only the contents of one cylinder will be lost. However, a diver must ensure that the cylinders are used alternately so that in the event of a free-flow, the diver will still be left with enough gas to safely abort the dive.
- Manifolded cylinders remove the requirement for a diver to alternate cylinder use, as the manifold has the effect of making the twin cylinders into one. However if a free-flow occurs, the diver must be able to react quickly and close down the malfunctioning valve as quickly as possible to minimise the gas loss from both cylinders.

- Most manifolds have a central isolation valve to isolate each cylinder in the event of a catastrophic loss of gas. Once the isolation valve has been closed, the diver will then shut down the malfunctioning valve whilst breathing from his backup regulator.
- Due to the positioning of the central isolation valve, which is normally directly behind a divers head, it can sometimes be difficult to reach during diving, and therefore difficult to close. To alleviate this problem, a 'Slob Knob' may be fitted, which is a long flexible cable routed through to the front of a diver. In the event of a free-flow the diver twists the remote know and this closes the central isolation valve.

- Some manifolds do not have a central isolation valve. With this type of manifold, the diver shuts down the malfunctioning valve as soon as possible.

Maintenance & Cleaning

- Fresh Water
    - Use copious amounts of fresh water when rinsing your cylinder down. Make sure that you hose under the cylinder boot. Let the cylinders air dry lying down – this lets any water remaining in the boot to drain away.

- Cylinder Valve servicing
    - Provided that the cylinder valve is washed in fresh water after use and is kept clean, there should be no need for it to be serviced between the intervals of cylinder test.
    - Although fairly basic, it is worthwhile considering having the cylinder valve serviced at the same time as the periodic inspection of the cylinder. Valves are stripped and the parts are bathed to remove salt and grease deposits, before being re-assembled with new 'O'-rings. Servicing will probably cost about £10 - £15 inclusive of parts.
    - It is not recommended that divers attempt to service their own cylinder valves, unless they possess specialist skills.

- O2 Cleaning
    - For Nitrox and Trimix cylinders, O2 cleaning is required annually. This is to ensure that no contaminants are present in the cylinder which may cause an explosion when the cylinder is filled with 100% oxygen. Oxygen clean cylinders should only be filled with a gas mix or double-filtered air to ensure that they are kept clean. If filled with 'standard' air, they must be re-cleaned before being used again for Nitrox/Trimix.

- Periodic Inspection
    - See section above

- Paintwork
    - Paintwork should inspected regularly to check for damage. Any damaged areas should be touched up with a proprietary metal paint (i.e. Hammerite) or an enamel paint (i.e. Humbrol). Timely touching up of the paintwork will stop corrosion of the cylinder.

Filling

The new European standards only make recommendations. This is important because it is not in itself illegal for a dive shop to fill a cylinder which does not have, say, a contents label conforming to EN 1089 Pt 2.

Air cylinders that are not used 'at work' and are currently in test according to BS5430 do not have to adopt labelling or painting. This will be left to the discretion of the owner but you are recommended to follow the requirements of the Carriage of Dangerous Goods Regulations.

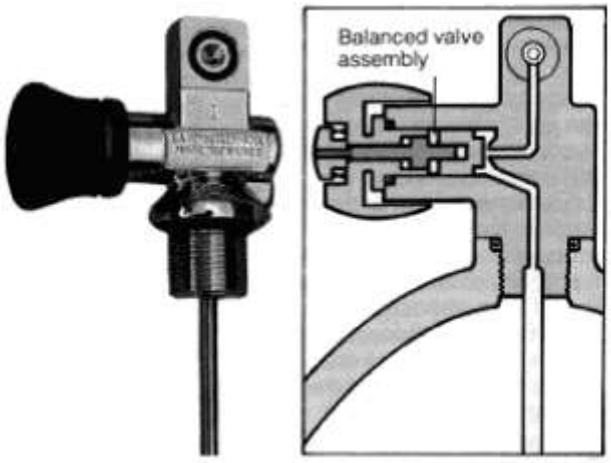
It is ultimately up to the filler to decide whether a cylinder is safe to fill or not. If they are not completely satisfied that this is the case, then they have every right to refuse to fill the cylinder.

Tanks when filled will heat up. Therefore it is important to fill tanks as slowly as practicable to maximise the available air, due the variation of pressure with temperature. Fully charged cylinders should not be stored in an environment that can be exposed to high temperatures e.g. a car boot or standing in direct sunlight for any length of time.

Storage

- Cylinders should be stored preferably horizontal to prevent damage.
- If storing a cylinder for a few months, never store it at full working pressure. A storage pressure of 30-50 bar is preferable. This prevents strain on the cylinder and valve and will prevent moist air from entering the cylinder.
- Do not store cylinders in extremes of heat. Try to store the cylinder in dry conditions and at room temperature to prevent any external corrosion or internal condensation.
- Fully charged cylinders should not be stored in an environment that can be exposed to high temperatures e.g. a car boot or standing in direct sunlight for any length of time.
- If a cylinder has not been used for 6 months or more, it is worth discharging the contents and refilled before use.

Cylinder Valves



- Usually made of chromed Brass
- Known as a Cylinder or Pillar valve
- Most modern valves are of a Balanced type (aka Cross-Flow) which means that high pressure air is acting on both sides of the valve assembly to prevent any stiffness while turning the valve
- Older valves may be unbalanced or glandless. An unbalanced valve has high pressure air acting on the inner valve and so is difficult to open or close when the tank is full. A glandless type is similar but is designed such that there is less wear on the valve parts.
- Some may have a pressure relief valve fitted called a burst disc
- Modular valves enable the extension of the valve directly with another valve to form an 'H-Valve' or via a Manifold to another valve and second cylinder.
- The valve is screwed into the cylinder neck with either a taper thread (on older cylinders) and sealed with PTFE tape or, on a modern cylinder, a parallel thread sealed with an 'O'-ring.
- Anti-Debris Tube
    - Internally fitted to the bottom of the valve to prevent internal cylinder debris – rust particles, water droplets from entering the valve mechanism if inverted.
- There are two types of valve connection :
    - DIN
        - DIN – Deutsches Institut fur Normung – A German manufacturing standard
        - Available in either 232 or 300 bar versions. 232 bar versions have a shorter thread so will not fit 300 bar cylinder valves. 300 bar versions can fit either 232 bar or 300 bar cylinder valves.

        - ‘O’-ring is fitted to the regulator thread, not the cylinder valve and is therefore internal and protected when in use
        - More compact and robust – less prone to ‘O’-ring failure
        - Used more in ‘Technical’ diving
        - Prevalent in Germany and some European countries. Also prevalent worldwide where German tourism is high (i.e. Maldives, Mediterranean, some Red Sea resorts)
    - A-Clamp
        - Maximum cylinder pressure of 232 bar
        - A-clamps for less than 232 bar have a narrower yoke fitting and should not be used on 232 bar cylinder valves, even if they fit!
        - ‘O’-ring fitted to the cylinder valve
        - May be dislodged if knocked.
        - Prevalent in the UK, USA, Caribbean and Red Sea, Far East – especially if not ‘Technical’ diving.
    - Some cylinder valves may be converted from DIN to A-Clamp with a removable ‘slug’, offering the best of both worlds!
    - Before going on holiday, check with the dive resort to see which fitting they use – it’s no use taking your A-Clamp regulator to a resort which only uses DIN compatible cylinders!
- See note above for Cylinder Valve servicing recommendations.
- It is wise to keep a few spare “O”-rings in your emergency dive tool kit.

Cylinder Glossary

Item	Description
A-Clamp	A type of fitting to enable a regulator first stage to be attached to a cylinder valve. Used typically in the U.K. and America. Can only withstand pressures of 232 bar or less.
Ally	Slang for Aluminium!
Bailout	See Pony Cylinder
Boot	A plastic or rubber moulded unit which fits over the base of a cylinder to protect it from damage and also enables steel cylinders to be stood upright.
Burst Disc	A pressure release system on some cylinder valves
Carrying Handle	Attaches around the cylinder neck to provide a convenient method of carrying a cylinder
Central Isolation valve	A valve in the centre of a manifold which, if shutdown quickly enough, will prevent a total gas loss from both cylinders of a twin-set.
Cross Flow	A modern balanced cylinder valve design
Cylinder	A vessel to hold compressed diving gas
Cylinder Valve	A valve threaded into the cylinder pillar which controls the venting of the cylinder contents.
Decompression Cylinder	An additional dedicated cylinder to be used for Decompression stops. Usually contains a specific high-oxygen content decompression gas.
DIN	DIN – Deutsches Institut fur Normung – A German manufacturing standard. A type of fitting to allow a regulator first stage to be attached to a cylinder valve. Available in either 232 or 300 bar versions. 232 bar versions have a shorter thread so will not fit 300 bar cylinder valves. 300 bar versions can fit either 232 bar or 300 bar cylinder valves. ‘O’-ring is fitted to the regulator thread, not the cylinder valve. Primarily used in continental Europe (particularly Germany) and in technical diving for its robust qualities.
Dumpy	A type of cylinder – short and fat – may be heavier than ‘standard’ long cylinders. May be more comfortable for divers with a short back length, but may also ‘roll’ a diver due to its higher centre of gravity.

Faber	A well known manufacturer of Steel diving cylinders.
Gas	May be normal breathing air, Nitrox (air with a higher content of Oxygen) or a mixture of gases which are used in deep technical diving – Trimix, Heliox etc.
H-Valve	A type of cylinder valve which has two independent gas outlets, which enables two first stages to be used as a redundancy measure.
Hang Tank	A spare decompression cylinder attached to a shotline or decompression trapeze.
Hydraulic Test	See Hydrostatic Test
Hydrostatic Test	A periodic test where the cylinder is pressurised to test the elasticity of the steel or aluminium
IDEST	The Inspectorate for Diving Equipment Servicing and Testing is an independent commercial organisation that has been set up to establish acceptable servicing and testing standards within the SCUBA industry. They work closely with the HSE.
J-Valve	A valve with a spring loaded mechanism that separates an internal reserve of air in the cylinder. The air reserve is accessed by pulling an external lever, secured to the valve, which is positioned towards the base of the cylinder. Not generally used today.
Luxfer	A well known manufacturer of Aluminium cylinders.
Manifold	Connects two cylinders together to form a twin-set. They require several 'O'-Rings
Mesh	A plastic or cloth cover for the cylinder body to protect it from knocks and scratches.
Modular	A modular cylinder valve is a valve that can be modified either into an 'H' valve or connected to another valve by means of a manifold.
'O'-Ring	'O'-rings are fitted internally to the cylinder valve to prevent the escape of high pressure gases. They are also used around the cylinder screw thread when the valve is attached to the cylinder. There will also be an external 'O'-ring on A-clamp cylinder valves to enable the correct sealing of an A-Clamp regulator. Usually made of rubber for use with air, but may also be made of an oxygen compatible substance (i.e. Viton) for use whenever a cylinder is filled with an increased percentage of oxygen.
O2 clean	Specialist annual cleaning of a diving cylinder to ensure that it is safe to be filled with pure Oxygen which is normally required for Nitrox fills. A dated certificate will be affixed to the exterior of the O2 clean cylinder.
Periodic Test	Under European directives since September 2002, a diving cylinder requires a visual inspection every 2½ years and a Hydrostatic test every 5 years.
Pillar	The neck of a cylinder
Pillar Valve	aka Cylinder Valve
Pony	An independent gas supply. Usually a 3 litre cylinder which is filled with the main diving gas with its own dedicated regulator. It is used whenever a major gas loss occurs or in an out-of-gas situation. Pony cylinders are usually attached alongside the main diving cylinder either by a bag or a clamp.
Pony Bag	The original method of carrying a pony cylinder alongside the main diving cylinder. Cheap, but not as easy to mount and release as a clamp.
Pony Clamp	A convenient, but more expensive, method of attaching a pony cylinder to the side of a main cylinder. Clamps usually enable the quick release of a pony cylinder.
PTFE	Polytetrofluroethylene – an inert man-made substance which can be manufactured as a tape and used to seal a cylinder valve into old-fashioned tapered cylinder threads.
Side Slung	A method of carrying additional, usually decompression (or stage) cylinders. Cylinders are clipped to the 'D' rings on a divers harness.
Side Mount	A Pony cylinder mounted on the side of a main cylinder usually with a bag or a clamp.

Slob Knob	A remote extension to a Central Isolation Valve to enable the valve to be operated easily and without joint dislocation!
Slug	A removable insert which converts a DIN cylinder valve to A-clamp use.
Stage Cylinders	Additional cylinders, usually side-slung, which contain specific gas mixes for various decompression stages
Tank	An 'Americanism' for Cylinder
Twin-Set	Two cylinders joined together with stainless-steel bands to enable large gas quantities to be carried. They may or may not be connected with a manifold.
Valve	The control outlet for cylinder gases
Valve Cap	Protects the cylinder valve outlet and associated 'O'-ring (if A-Clamp)
Visual Inspection	A detailed inspection of the interior of a diving cylinder.
Y-Valve	A type of cylinder valve which has two independent gas outlets, which enables two first stages to be used as a redundancy measure.