USER MAINTENANCE AND PERIODIC INSPECTION GUIDE



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SAFER®

COMPOSITE HIGH PRESSURE GAS CYLINDERS

TÜV SÜD ISO 9001

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1. History of the Company

Techplast Sp. z o.o. was established in 2002 by Adam Saferna. The Company became a leading manufacturer of composite cylinders in Poland, effectively developing its activity both in domestic and foreign markets. We used to manufacture PET items. We cooperated with IKEA, Aquafilter (USA) – European branch.

We guarantee the highest quality of Safer® composite cylinders thanks to use of the highest quality specialized materials for the production of them.

We were developing in many areas of production, however answering to the needs of a market in 2007 we focused mainly on manufacture of composite high pressure cylinders that are in high demand. In the following few years we have focused our activities on developing a new technology of composite containers production which would significantly lower a cylinder's weight and ensure its higher safety and durability.

This way a PET based technology cylinders were developed as well as cylinders based on carbon fiber and aramid over-wrapping. In 2010 we completed the research and obtained an official certificate for a 6.8 l capacity container.

Two years later we were recognized internationally by receiving a "Kevlar Innovation Reward 2012" for creation of a new generation of pressurized containers for lighter and safer gas storage.

Product innovation

Thanks to the use carbon and aramid fibers we managed to strengthen the structure of traditional containers while lowering their mass at the same time. These lowered mass containers are the perfect solution for medical industry. Our products are also perfect for entities that use their cylinders in difficult or even extreme conditions.

2. General recommendations

This instruction contains important information which serves for ensuring safety of operation and maintenance of high pressure composite cylinders.

This product will carry out tasks for which it is intended only when it is used, serviced, repaired and controlled according to its intended use and to the recommendations stipulated in this User Guide.



Operation that not complies with this User Guide may endanger safety of people and tangible assets.

Filling, maintenance and repair of composite cylinders can be done only by qualified and competent staff, equipped in proper training and qualifications consistent with the manufacturer's requirements and with national provisions in force.

In case the composite cylinders are serviced or repaired by not employed or not authorized staff by Techplast, or if the containers are used in the way that is inconsistent with their application, responsibility for their incorrect operation shall be transferred to a user.

The manufacturer shall not be liable for damages caused by improper use, operation, servicing and repair of a cylinder.

All alterations to the design can be done solely under a written consent of the manufacturer.

Do not use a vacuum.

In case of ambiguity please turn to the manufacturer for explanations. Contact data can be found online at www.safercyliners.com or send an email to our technical service at service@techplast.net.

3. Design and manufacture

Design and manufacture of the SAFER® pressurized cylinders by Techplast has been adjusted to demands stated in the EN 12245 or ISO 11119-3 standards. A design of a cylinder is based on a PET liner and overwrapping of carbon and aramid fibers in epoxy matrix.

PET ultralight polymers were used for the liner of SAFER® pressurized cylindres, thanks to which the lightest possible high pressure composite container has been obtained.

PET polymers are compatible with stored gas, according to EN ISO 11114-1, they enable the collection of pressurized gases of: air, nitrogen and its mixtures, they do not react with the above mentioned gases and their mixtures which guarantees gas purity within the whole period of its storage and lack of corrosion generation.

Layers of carbon and aramid fibers over-wrap, winded on the PET liner by specially designed machines according to precisely determined pattern, in epoxy matrix are soaked in precisely determined temperature by manufacturer. They ensure proper rigidity and durability which enables the storage of high pressurized gases. Outer layer is made of epoxy resin, which protects the pressurized cylinders against ambient conditions and against scratches and impacts.

Some pressurized cylinders are equipped with a cup and a bottom’s guard. These elements are made of PVC - impact, deformation and abrasion-proof material.

3.1 Design

The following figure shows a typical design of a SAFER® composite cylinder.

1 **Connection part** made of aluminium

2 **Liner** made of PET polymers

3 **Braid** of carbon and aramid fibers in epoxy martix

4 **Epoxy resin layer** giving coloring of the cylinder

5 **Outer coat** made of connection of glass fibers and epoxy resins



3.2 Manufacture

The best property materials are the guarantee of the highest quality. Technology and manufacture process
of the SAFER® composite cylinders are protected by the patent.

All manufactured composite cylinders are submitted to complex inspections under supervision of a notified body.

In Techplast cylinders are manufactured according to quality assurance procedures and to the ISO 9001 and to the EN 12245 standard demands composite cylinders are manufactured, tested and permitted according to the following criteria and demands.

Cylinders are manufactured in batches of maximum 200 items plus destructive tests cylinders.

In each batch:

100% of cylinders – visual inspection. Inner and outer surfaces of finished cylinders cannot have defects that can negatively influence safe operation of cylinders.
100% of cylinders – weight control
10% of cylinders – diameter inspection
100% of cylinders – capacity measurement
100% of cylinders – test pressure test (hydraulic test) in ambient temperature.

Pressure in cylinders is increased in a controlled way until the test pressure is achieved. Cylinders are pressurized under stabile test pressure within at least 30 seconds. Accuracy limits of obtained test pressure should be equal to +3% - 0% of test pressure value. During the test cylinders are inspected for leakproofness and for resistance to stable deformations.

1 item of a 200 cylinders batch is subject to a test – test of resistance to pressure change cycles with a test pressure in ambient temperature.
A cylinder is subject to subsequent series of pressure increase and decrease. Cylinders are tested with 12 000 cycles to a test pressure value and they should pass them without damages characterized by a leakage or deformation.

Conducting and meeting the demands of the above procedure allows the marking and commissioning of cylinders with indefinite NLL lifespan.

1 of a 200 cylinders batch is subject to a test of a cylinder's strength (burst test). Bursting pressure is equal or higher than the minimum designed bursting pressure and is equal to at least 2 x of the test pressure. Bursting initialization should occur in the cylindrical part and the cylinder should remain in one piece.

4. Marking

Pressurized cylinders are designated with an information label conformable with the requirements of the EN 13769 standard and with requirements of the ADR/RID provisions.

Below is a sample of a label used for compressed air pressurized cylinders for a breathing apparatus:



Meaning of the designations used:

Oznaczenie	Dotyczy
EN 144-1	Standard's number concerning the thread
M 18x1,5	Thread type
PL	Cylinder country of manufacture
SAFER	Cylinder manufacturer
S/N: 01C/15/00001	Cylinder serial number
Liner: PET	Type of a lining material
2,80 KG	Weight of an empty cylinder without a valve
V 6,8L	Water capacity of cylinder
PW 300 BAR	Working pressure at 15ºC
PT/PH: 450 BAR	Test pressure
CE 1017	CE mark and Notified Body Number
EN 12245: 2009	Number of the standard concerning the design specification, manufacture and control of composite cylinders.
CZ 10 17	Notified Body's country and its sign
2015/05	Date of first hydrostatic inspection
FIN: NLL	Designation informing that a vessel has indefinite lifespan (non-limited life)
TS: -40ºC / +60ºC	Range of working temperature
2020/05	Next inspection date

** First periodic inspection's date is determined according to national requirements*

A cylinder that does not have a label or the label of which is damaged in such a way that is not possible to identify its designations one should be immediately withdrawn from use and transferred to manufacturer for repair of its label.

A label can be repaired only by the manufacturer or can be replaced with a new one under condition of univocal identification of the cylinder.

5. Assembly and disassembly of the valve

5.1 Operations before a assembly of the valve

Valves can be mounted to the cylinder only by authorized service agent!

Before assembly of a cylinder valve one should check:

1 Condition of the cylinder interior:
   - cylinder interior should be free from any dust or impurities,
   - cylinder interior should be dry.
2 Condition of the cylinder exterior and its designations,
3 Condition of a thread on cylinder neck:
   - - damaged thread makes it necessary to scrap the cylinder,
   - - soiled thread needs to be cleaned
   - - thread parameters should be checked with proper gauges if needed
4 Condition of a gasket groove:
   - damaged groove makes it necessary to scrap the cylinder
   - soiled groove should be cleaned
5 Condition of the cylinder valve:
   - thread surface should be smooth and free from damages
   - in case of damage of a valve thread (surface, coils etc.) or any other part of the valve one should proceed according to the guidelines of the manufacturer of the cylinder valve or the manufacturer of the respiratory protective device
   - if needed, the thread parameters should be checked with a proper gauge,
   - soiled valves should be cleaned

Any damages or soiling can cause leakage and inefficiency of a complete cylinder. In extreme cases they may lead to health and life risk of users and other people.

In case of doubts regarding the condition of the cylinder neck thread or the gasket groove one should pass the cylinder to the manufacturer in order to gain their technical opinion or to repair of damaged elements, as far as possible.

5.2 Assembly of a valve to the cylinder

A cylinder should be mounted at a specially designed post that ensures its stabile position. Elements of the cylinder grip should be effectively protected against possibility of external layer damage.

It is strictly prohibited to oil and lubricate the valves and parts of the cylinder.

Valves should be screwed into the cylinder according to provisions, acts and standards applicable in a user's country.

It is recommended to screw valves into cylinders according to the ISO 13341 standard.

5.3 Disassembly of a valve from the cylinder



Cylinder valve can be disassembled only from a cylinder that is fully emptied.

One should make sure that the cylinder is empty by slowly opening the cylinder valve with its exhaust outlet directed away from a user.

The cylinder should be mounted at a specially designed post that ensures its stabile position. Elements of the cylinder grip should be effectively protected against possibility of the external layer damage.

6. Filling the cylinder

Filling the cylinders with gas can be done only by entities and persons with proper authorization according to the provisions, arrangements and standards applicable in the country of use.

Filling pressure cannot exceed the working pressure shown at the cylinder label.

Material of cylinders is a good heat isolator, thus the cylinder temperature rise will be slow but on the other hand the return of the cylinder surface temperature will definitely slower than in steel cylinders.

Return of a cylinder temperature to ambient temperature results in pressure drop inside the cylinder.

- In order to obtain maximum pressure, it is necessary to refill the cylinder.
- In order to obtain maximum pressure one should optimize filling procedures (for example a change of filling rate).

During the process of filling the cylinder immersed in water, small air bubbles can appear on the cylinder surface. It is the effect of air release that is bound between the liner layer and the layer of composite fibers. This process may last for a few minutes since the end of the cylinder filling.

Slow filling

Slow filling should be carried out in the following way:

Fill a cylinder without pressure (empty) with compressed gas up to 5 bar and leave it in this state for 5 minutes.

It is recommended that the filling rate is slower than 30 bar/min. It ensures the temperature drop that was created during filling.

Fast filling

During normal use cylinders can be filled at a higher rate than recommended however not higher than the temperature that would cause a cylinder temperature rise above 60°C.

Cylinder temperature rise during its filling is a natural phenomenon. Fast filled cylinders show high temperature rise which results in pressure drop after cool-down of a cylinder to ambient temperature. Therefore when a cylinder temperature returns to ambient temperature one should control cylinder pressure and if necessary one should complete its pressure up to working pressure.



Cylinder temperature during filling cannot exceed 60°C.

7. Protection against prohibited moisture

Cylinders should be filled only with compressed gases that meet the requirements of their standards.

In order to avoid possible soiling or dampness of a cylinder interior, manufacturer requests to sustain minimum pressure of 2 bar.

8. Maintenance of a cylinder

A cylinder during operation should demand maintenance especially after its use in difficult conditions

Maintenance of a cylinder should be carried out by persons with proper authorization, training and experience in a properly equipped service center and should act according to the ISO 11623 standard.

8.1 Outer inspection

Outer visual inspection should be carried out in order to inspect:

- soiling,
- if the label is legible and if all designations are univocal and identified,
- if a cylinder's life-span has not been exceeded,
- if a periodic inspection limit has not been exceeded,
- if a cylinder and its valve have any outer damages that preclude their further use.

Soiled cylinder should undergo activities according to the 8.2. and 8.3 items.

Damages to a cylinder should be identified based on information contained in item 10 of this guide and proceed according to its recommendations.

8.2 Washing and cleaning the cylinder surface

Cylinder should be cleaned in the way that does not damage its outer coat.

Cylinder can be washed with warm water (temperature should not exceed 45^{o}C) with mild washing agents: soap, cleaners for washing dishes and their concentrates.

For stubborn stains of chemical origin e.g. paints one can use extraction naphtha.

It is prohibited to use corrosive substances for cleaning cylinders.

8.3 Drying the cylinder interior.

Cylinders can be dried in a specially designed devices for this purpose, by blowing the interior of a cylinder with a dry, clean, and not soiled with oil, warm air the temperature of which should not exceed 60^{o}C.

It is prohibited to dry a cylinder with negative pressure (vacuum).

8.4 Leak test

In order to perform the leak test, the cylinder must be filled with compressed gas (air, nitrogen) up to work pressure and left pressurised for at least 2 hours. After that time the cylinder can be immersed in water.

If air escapes through threaded connection between a cylinder valve body and a cylinder neck body, it indicates:

- - inaccurate tightening of the cylinder valve,
- - damage to the gasket,
- - damage to the gasket groove,
- - wrong packing of the taper thread with the sealing strip.

After the test has been carried out a cylinder should be dried with methods described in item 8.3. of this guide.

9. Periodic inspections

Periodic inspections and inspections of composite cylinders are regulated by the EN ISO 11623 standard.

Control and testing composite cylinders can be carried out only by authorized entities and persons.

Cylinders that have not passed the inspection or the test are rejected. If a reason for a cylinder rejection is a damage that can be repaired, such cylinder should be repaired and should undergo re-inspection in order to be admitted to further use. Repairs are carried out according to the manufacturer’s recommendations.



When performing a pressure test with the measurement of the tank's expansion, it should be taken into account that air trapped between the PET Liner and the composite layer can escape. The measurement device should be able to perform degassing of the chamber during the test.

9.1 Outer inspection

A cylinder should be properly prepared to outer inspection, by cleaning, washing, brushing and drying with methods and agents described in items 8.2. and 8.3.

Composite cylinders should be carefully checked against outer damages like: chafing, impact, indentation, decrement, chip, exfoliation, melt down etc. Depending on a damage, there are three levels

Level 1 – small damages of outer surface like small chafing, small indentations, incisions and scratches. Such cylinders can be re-used.

Level 2 – damages that can be and should be repaired, like: decrements, chips, incisions, gouges etc. After repair such cylinders must be re-tested against test pressure. A cylinder's repair can be done by the manufacturer.

Level 3 – damages exceeding level 2, e.g. damage to the carbon fiber layer. Such cylinders must be rejected and excluded from further use and scrapped.

Detailed description of damages with their levels is described in Chapter 10 of this guide: Damages and repairs.



Damaged cylinder must be immediately excluded from operation, emptied and submitted for evaluation to competent services (technical organizations).

9.2 Inner visual inspection

Inner visual inspection aims to reveal all abnormalities in form of soiling and humidity.

All kind of soiling should be removed by emptying out, rinsing with stream of water with possible use of delicate washing agents, blown out with compressed air.

It is prohibited to use for this purpose any chemical agents, sharp objects, very strong jets of water (high pressure washer), water steam, sand blasting or shot blasting and similar techniques.

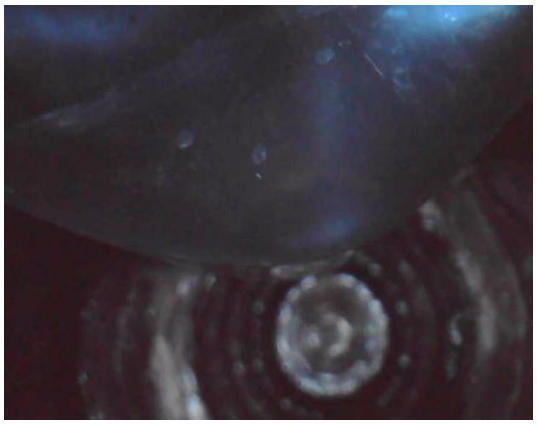
Any visual changes arise from the high pressure to which PET liner is subjected during the duty cycles. These visual changes do not affect the performance or safety of the cylinder. SAFER® cylinder should be controlled inside only in terms of moisture and purity.



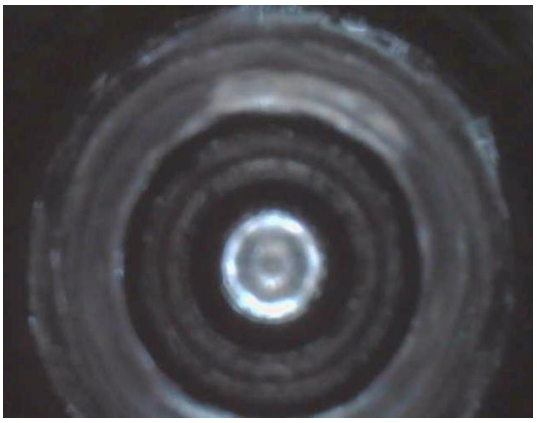
Example picture of PET liner with visual changes

The effect of "**BULGING**" of the liner inside the cylinder is the result of very low temperatures during the rapid pressure drop to atmospheric pressure.

To eliminate the effect of "**BULGING**" in the process of rapid rapid pressure drop, the cylinder must be filled to a pressure min 5 bar and leave for at least 5 minutes.



Bulging efect visible inside the cylinder



Cylider interior after filling to 5 bar

Thanks to the use of PET liner there is no probability of corrosion generation inside the cylinder.

Internal thread of a cylinder neck and gasket groove is also inspected as they should be free from damages.

If necessary, the thread condition should be inspected with a proper gauge type.

9.3 Rejection and destruction of cylinders not suitable for further use

In order for cylinders deemed unfit for further operation not to be filled again, they should be emptied and destroyed by:

- mechanical crushing of a cylinder
- sawing the cylinder neck right at the cylinder cup
- sawing the body of a cylinder across for at least two parts
- drilling of a cylinder body.



It is unacceptable to scrap a pressurized cylinder. It can cause risk of health or life loss.

10. Damages and repairs

All kind of damages should be repaired exclusively by persons trained for these tasks and authorized by Techplast. Repair of a label can be made only the manufacture's service center. The following types of damages are distinguished:

- wear damages,
- cut damages,
- impact damages,
- thermal damages,
- chemical damages,
- delamination,
- structural damage.

10.1 Wear and cut damages

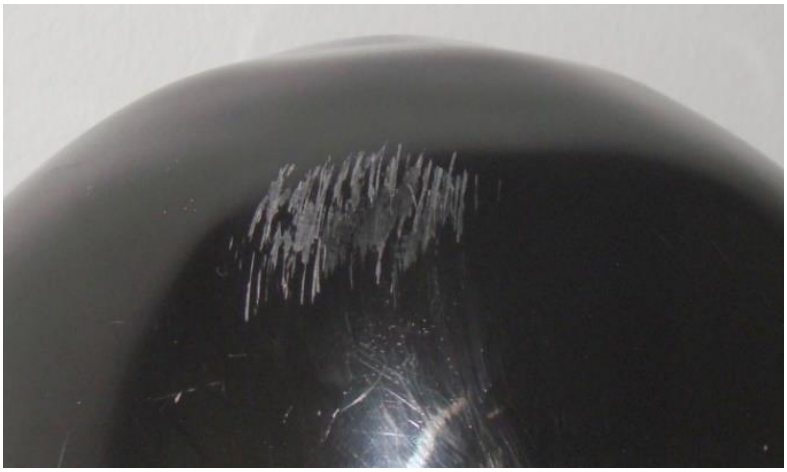
Levels of damages have limiting parameters according to the undermentioned table:

Dimension of outer diameter [mm]	Level 1	Level 2		Level 3
	Depth [mm]	Depth [mm]	Length [mm]	Depth and Length [mm]
116	≤0,25	≤0,70	≤ 58,00	> level 2
158	≤ 0,35	≤ 1,00	≤ 79,00	> level 2

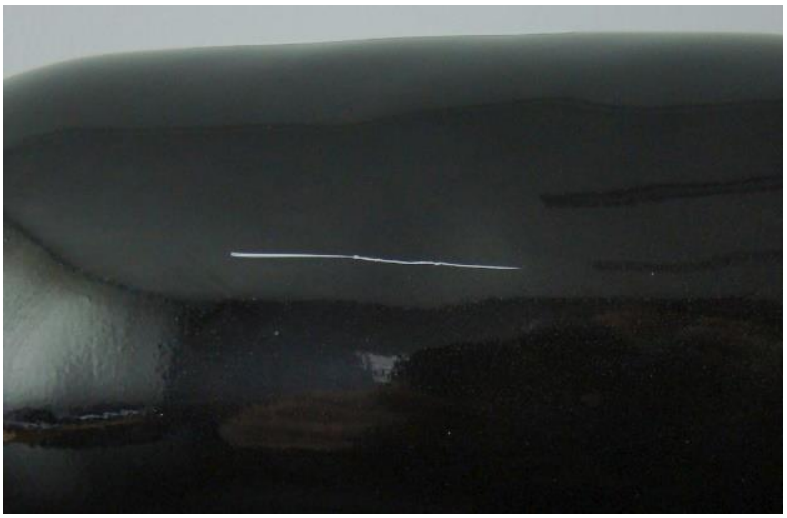
Level 1

Surface damages that not exceed the depth defined in the table. Damages do not influence cylinder's technical parameters; they just lower its esthetics. A cylinder with such damages can be allowed to use.

Wear damage level 1



Cut damage level 1



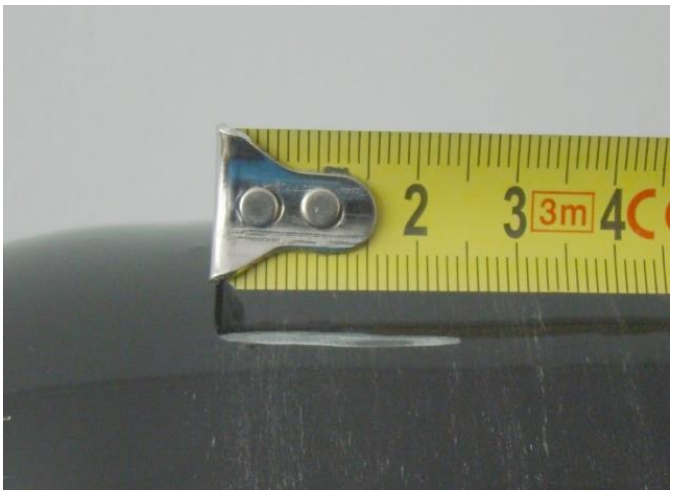
Level 2

Damages of depth and length defined in the table. Damages can be repaired.

Measurement of a depth damage



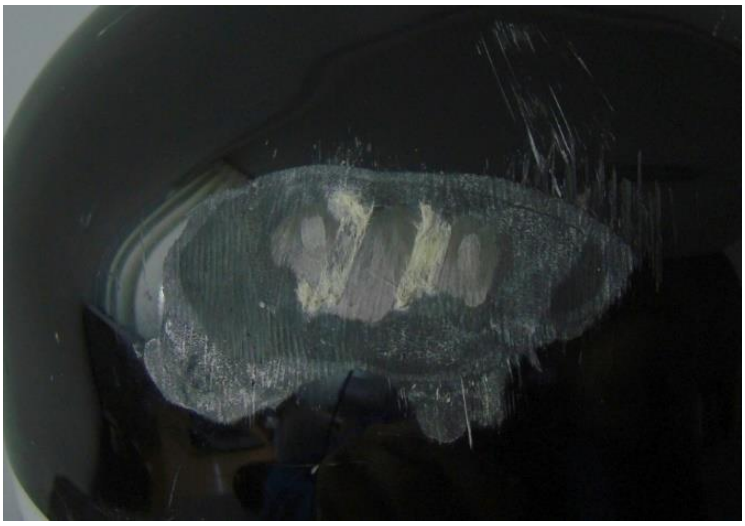
Measurement of a length damage



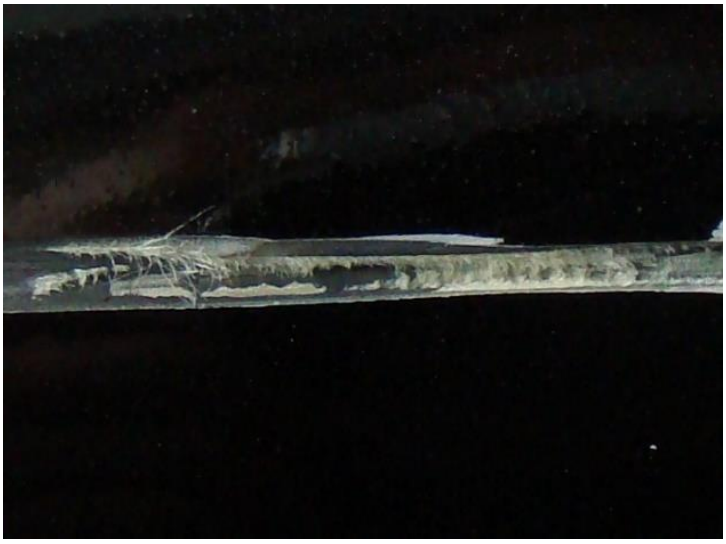
Level 3

Damages exceed level 2 damages and are serious enough to make a cylinder not suitable for repair. A cylinder should be rejected and disposed.

Wear damage level 3



Cut damage level 3



10.2 Impact damages

Impact damages are surface deformations of indentation, deformation and delamination of braid, delamination and fractures of outer coat.

Level 1

Level 1 damages include relatively small damage to the outer coat which can be accompanied by small hairline cracks. Such damages do not influence technical parameters. A cylinder with such damages can be allowed to use.

Impact damage level 1

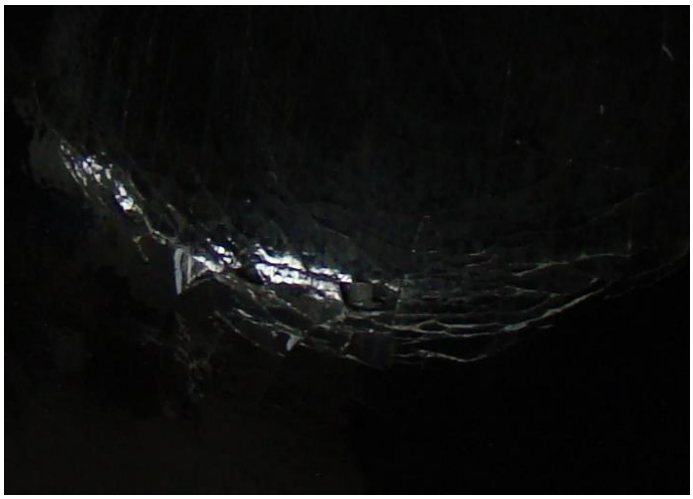


Level 2

Damages as in level 1 but not exceeding the depth and length parameters defined for wear and cut damages of level 2.

Level 2 damages can be repaired and after a positive pressure test the cylinder can be used.

Impact damage level 2



Level 3

Damages exceed level 2 damage parameters, they concern large areas of braid damage including its delamination; a cylinder structure is damaged; outer coat has many cracks and chips.

Level 3 damages disqualify a cylinder from use.

Impact damage level 3



10.3 Thermal damages

Thermal damages can come from high temperature or a flame. These are sooting of a cylinder surface, discoloration of outer coat, its melting or charring; a label traceability can be damaged.

There are 2 damage levels.

Level 1

Damages concern the outer layer and a small area of the outer coat in respect of sooting and discoloration. A cylinder after washing and drying and after re-inspection should not have any further damages. Such damages require to do hydrostatic pressure testing. Positive result of the above testing makes the cylinder allowed to further use.

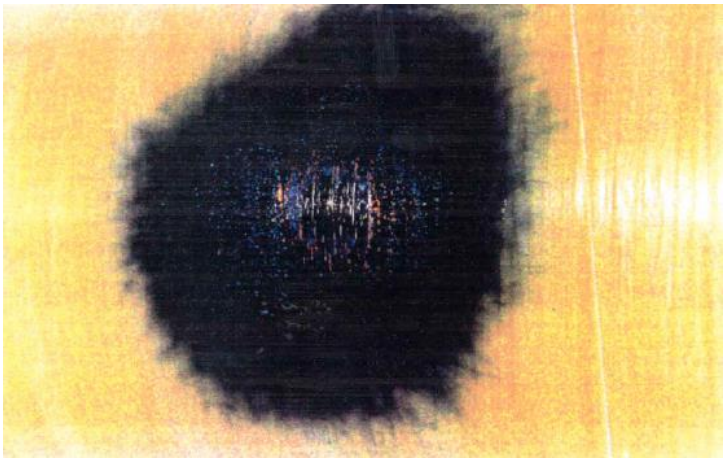
Thermal damage level 1



Level 3

Damages that exceed level 1, especially melting or charring the outer surface and epoxy matrix, burn and delamination of braid disqualify a cylinder from use and make it disposed.

Thermal damage level 3



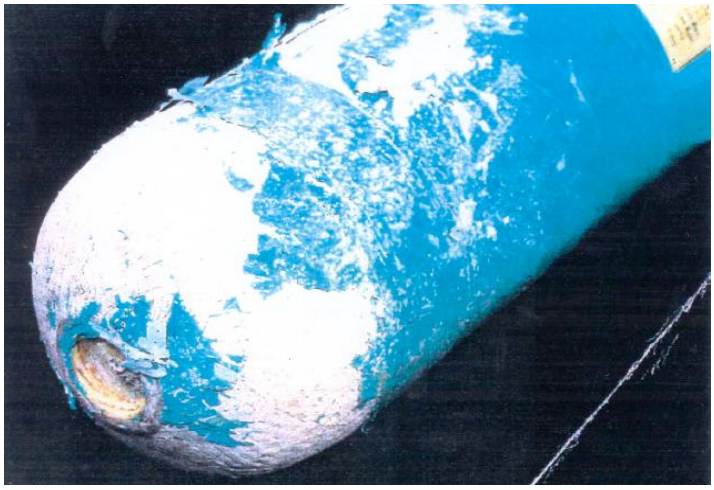
10.4 Chemical damages

Chemical damages occur when a cylinder gets in contact with chemicals that negatively influence materials of which the cylinder design is made of. Aggressive chemicals can dissolve outer coat and epoxy matrix, make them ductile and sticky.

Level 3

Damaged outer coat, glass fiber braid and epoxy matrix. The cylinder should be rejected and disposed.

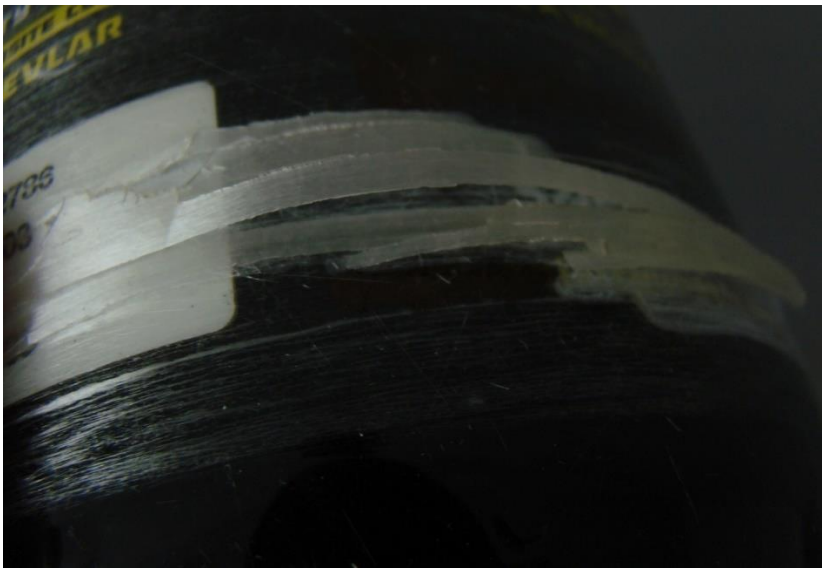
Chemical damage level 3



10.5 Delamination

Delamination is a separation of particular layers of a cylinder design. Delamination that occurs most often is delamination of glass fiber braid from epoxy matrix and label. It is a result of wear, cut and impact damages. It occurs in the form of visible cross-cut or tear of glass fiber.

Example of delamination



Damaged cylinders due delamination can be repaired only by the manufacturer’s service center.

10.6 Structural damages

Damages to the structure / design of a cylinder consisting in a change of its shape and form i.e. bulging, recess, neck bending are unacceptable and make such cylinder rejected and disposed.

Damages to the outer coat in the cylinder neck area can occur as a result of continuous changes in temperature and pressure. They consist in occurrence of a small gap generation around a cylinder neck. The damage does not influence technical parameters of the cylinder and after repair it can be further used.

10.7 Repair of damages

Repair of damages should be carried out by properly trained staff authorized by the manufacturer.

11. Storage

Stored cylinders should be:

- stored under supervised condition;
- protected from mechanical damages, protected against a fall and rolling;
- stored in a clean and dry condition, protected against soiling and exposure to chemicals and corrosive agents;
- protected from unfavorable temperatures (recommended storage temperature is -30°C to +60°C)
- tanks with pressure valves should be stored pressurised to min. 2 bar
- tanks without pressure valves should be fitted with transport caps with o-rings.

12. Transportation

The manufacturer recommends the use of European ADR Agreement, which concerns an international carriage of dangerous goods by road. Cylinders should be transported in containers, hoppers, pallets and similar ways of cylinder transportation ensuring avoidance of damages and soiling. Tanks with pressure valves should be transported pressurised to min. 2 bar. Tanks without pressure valves should be fitted with transport caps with o-rings.



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