

Handling of Full Metal and Composite Gas Cylinders During and After Exposure to Excessive Heat or Fire

Introduction

All gas cylinders, whatever the gas content, are potentially dangerous when exposed to fire or excessive heat. Excessive heat exposure can weaken the cylinder and its closure and, in extreme cases, result in the failure of the cylinder or its closure.

Note: For the definition of “excessive”, see TB 21 Recommendation for Cooling and Heating of Gas Cylinders [1].

It is essential that customers and first responders, such as the emergency services, at incidents involving gas cylinders exposed to excessive heat or a fire have the appropriate advice on the correct handling of gas cylinders in such conditions.

The first edition of this Safety Information document provided guidance, on how to handle metallic gas cylinders (so called type I) exposed to fire or excessive heat and is intended for persons familiar with the properties and safe handling of gases and gas cylinders. This revised Safety Information also considers composite cylinders (so called type II, type III and type IV) when used as single cylinders. For composite cylinders used as elements in trailers EIGA has published safety considerations which are given in TB 19: Safety Considerations in Case of Fire of Composite Cylinders or Tubes Used in Trailers [2].

Since their Introduction single composite cylinders are in use for different applications. Therefore, gas company plants, cylinder transport trucks and end user locations have to handle metallic and composite cylinders.

Customers and emergency services should be made aware of this SI, as well as the personnel in EIGA member companies who deal with cylinder incidents.

When the term “cylinders” is used within this SI, it is also intended to include “tubes”.

For type I cylinders exposed to heat, see also EIGA TB 21 [1]. This can be used as a guide also for composite cylinders.

Within this Safety Information the following definitions are used

- Type I cylinder (metallic): Full metal cylinder with no overwrap.
- Type II cylinder: Hoop wrapped cylinder with a load-sharing metal liner and composite reinforcement on the cylindrical portion only.
- Type III cylinder: Fully wrapped cylinder with a load-sharing metal liner and composite reinforcement on both cylindrical and the dome ends.
- Type IV cylinder: Fully wrapped cylinder with a non-load sharing liner and composite reinforcement on both the cylindrical portion and the dome ends.

BASIC HAZARDS OF METALLIC CYLINDERS (TYPE I) INVOLVED IN A FIRE

The properties of some gases or the construction of their cylinders and/or valves can introduce additional hazardous factors that need to be addressed during and after fire events.

Any type I gas cylinder that is exposed to fire or excessive heat can rupture due to an increase of pressure and decrease of mechanical properties, caused by the increase of temperature. This is valid even for cylinders that have pressure relief devices (PRD) because, in extreme circumstances, the device cannot operate quickly enough.

Hazards arise from pressure shock as well as parts of cylinders that can become projectiles. For flammable gases the flame from a PRD release can be greater than 10 meters in length.

The degree of hazard depends on a number of factors, such as extent of exposure to the source of heat or fire, the quantities of gases involved, site-specific storage conditions (indoors or outdoors) and the presence of people and/or traffic routes nearby.

After exposure to excessive heat or fire, type I cylinders need to be inspected before being reintroduced in service.

The degree of hazard depends on a number of factors, such as extent of exposure to the source of heat or fire, the quantities of gases involved, site-specific storage conditions (indoors or outdoors) and the presence of people and/or traffic routes nearby

BASIC HAZARDS OF COMPOSITE CYLINDERS (TYPE II, III and IV) INVOLVED IN A FIRE

Due to the combination of liner material (metallic or non-metallic), plus an overwrapping of fiber material, such as glass, aramid and carbon, embedded in a resin material, the heat transfer from excessive heat or fire to the pressurised gas is lower than for type I cylinders. As a result, the increase of pressure caused by the increase of temperature is much less and consequently the use of a PRD, such as a bursting disk, is not effective.

Some cylinders with a non-metallic (plastic) liner will melt and leak before the composite cylinder would burst.

Analysis of previous incidents has shown that the valve/closure can fail before cylinder failure, especially when exposed to fire over a long period of time. In this case the valve seat melted away and the gas was released via the valve, thereby also reducing the pressure within composite cylinder and avoiding the burst of the cylinder. EIGA members have seen scenarios where a mix of metallic and composite cylinders were exposed to fire. Several type I cylinders had burst, while the composite cylinders next to them did not burst because they were depressurized through the valve via the melted valve seat. In some cases, the valve had sheared off and the full gas content was able to vent in a very short time.

After exposure to excessive heat or fire, composite cylinders, as with type I cylinders, need to be inspected before being reintroduced in service. The inspection of composite cylinders is easier to detect excessive heat or fire traces compared to metallic type I cylinders.

The degree of hazard depends on a number of factors, such as extent of exposure to the source of heat or fire, the quantities of gases involved, gas properties (e.g. flammable), site-specific storage conditions (indoors or outdoors) and the presence of people and/or traffic routes nearby.

IMMEDIATE ACTIONS FOR full metal and composite CYLINDERS (type I, II, III and IV) INVOLVED IN FIRE

Instructions for first response personnel to be taken in the event of a fire:

- **FIRST: Raise the alarm. Evacuate the area** to a safe place, that is either a distance of more than 200m away from the fire or behind a solid object or wall
- **SECOND:** Ensure the emergency services are called immediately.

Instructions for actions to take in the time between the above actions being completed and the arrival of the emergency services:

- Do NOT move any cylinder that is being or has been exposed to direct fire or flame.
- Do NOT return to the area to take action.
- Do NOT attempt to open valves to let cylinders vent.

- Make a record of the time that the fire or heating started, and if possible, the product, number and location of gas cylinders. Give this information and all the information outlined in this SI to the emergency services on arrival.

Do not attempt to intervene before the Emergency Services arrive, unless there is a trained on-site emergency team that has an approved procedure to follow with regard to a fire involving cylinders. Intervention to stop the fire must take account of the need to immediately start cooling the affected cylinders and the potential hazard of the cylinders. Possible emergency team actions could include deluging cylinders with water from a safe location, for example from behind heavy machinery or a solid wall.

The emergency services team should be informed that, beside the bursting of cylinders, with the effect of flying projectiles, also fire flames out of the cylinders can result in an additional risk for the fire brigade.

It is easy to cool down type I cylinders by water, due to ease of heat transfer through the cylinder shell, but less efficient in the case of composite types.

Intervention shall NOT include moving the cylinders to improve the access for water cooling or lifting the cylinder into a water bath. Care shall be taken not to knock cylinders over when using fire water hoses for cooling.

If nearby the cylinders when the fire or heat event starts and it is safe to do so, it can be possible to close any open cylinder valves. (especially for flammable and oxidizing gases because they may increase the intensity of fire)

An example of when it is potentially safe to intervene and close a cylinder valve is for a hose or gauge fire to equipment down-stream of the cylinder, where there has been no direct or flame impingement onto the cylinder body.

For more information see also EIGA HF 06 Organisation - Site Emergency Response [6]

SUBSTANCE SPECIFIC HAZARD INFORMATION - FOR CONSIDERATION DURING/AFTER FIRES

In addition to the common hazards of all cylinders in fires as described above, there could be additional substance specific hazards relevant to the contents of the cylinder. The gas product specific information can be found in the applicable material safety data sheet, MSDS. A summary of some properties which are of concern include:

Cylinders containing toxic or corrosive gases

Gases which are toxic/corrosive can be released and dispersed and/or consumed during a fire. Therefore, any action shall be decided and directed by a trained and competent person who is able to fully assess the location of the cylinders, exposure to fire or excessive heat, and then take the most appropriate measures to reduce the risks.

Cylinders containing a flammable gas

A flame from a gas cylinder, and whose valve cannot be closed, shall normally be left to burn while cooling the cylinder with water. If the flame is extinguished but the gas continues to escape into a confined or enclosed space, it can lead to an explosion.

Hydrogen flames are not always visible. This fact should be highlighted in training of personnel transporting and using hydrogen.

Note: all gases except oxygen do not support life. Consequently, adequate precaution shall be taken in case of release of such gases (e.g. risk of asphyxiation).

ACETYLENE CYLINDER DESIGN (cylinder shell is type I full metal only)

Acetylene cylinders (type I)

Normally, only type I cylinders are used for acetylene.

Acetylene cylinders, if heated by flame or fire, may explode – even after the fire is extinguished.

For dealing with acetylene cylinders involved in a fire see the following section for acetylene.

Acetylene is a very efficient and necessary gas with unique characteristics, which cannot be replaced with other

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