OCDEM, Churchill Hospital, Oxford OX3 7LE

SOP number: OCDEM RA 12

Head of Department: Prof Fredrik Karpe
DSO: Sandy Humphreys
BSO: Prof Patrik Rorsman

Effective date: 1st June 2016
Updated: 25 may 2016
Version: 2.0
Supercedes: 1.2

The Transport, Storage and Use of Compressed Gas Cylinders

Contents

1 Introduction

Compressed gas cylinders are large, heavy and awkward to move. They contain compressed gas at high pressure designed for either liquid or vapour withdrawal; these gases can be either inert (e.g. nitrogen, argon, helium), flammable (e.g. hydrogen, methane), non-flammable (e.g. carbon dioxide), reactive (e.g. oxygen) or toxic (there are currently no toxic gases in OCDEM). Four of these categories of cylinders are held within OCDEM; flammable gases are located in lab F19. These gases may also be asphyxiants. This document is a general risk assessment for their handling, use and storage, and does not address individual gases in detail.

2 Persons at risk

- Laboratory staff, students and visitors.
- Young persons (those less than 18 years), pregnant or breast feeding woman and other vulnerable persons will need a separate risk assessment.

3 Potential hazards

- Health hazards :
  They may contain gas which may be toxic or asphyxiating.
  Flammability: Hydrogen and methane are used in lab F19
  Hydrogen is an extremely flammable gas, with a flammability range of 4% to 75% in air by volume; it is much lighter than air and will collect in roof spaces. Mixtures with air constitute an explosion hazard. It is non-toxic; has no colour or smell, and can cause asphyxiation by replacement of oxygen. Hydrogen burns with an almost invisible flame and is therefore difficult to detect.
  Methane is extremely flammable with a low flash point and a flammability range of 5% to 15% in air by volume; it may travel a considerable distance to an ignition source. Mixtures with air constitute an explosion hazard. It is a colourless, odourless gas which may cause asphyxiation by replacement of oxygen.
- Manual handling:
  Pressurised gas cylinders are very heavy (up to 80 kilos) and unstable objects; they can present considerable danger to those handling them.
- High pressure:
  Apart from the chemical risk from these gases, serious physical damage can be caused by exposure to the full force of escaping gas; a cylinder pressure of 300 bar is equivalent to two tons per square inch.
- Regulator failure:
  Gas cylinder valves are very robust and difficult to break. However gas pressure regulators are much less robust and if damaged may allow the catastrophic escape of gas.

4 Risks

For an untrained person, the most probable sources of injury are from:

- Incorrect handling of a cylinder when moving the cylinder.
- Incorrect fitting of the pressure regulator allowing the escape of gas.
- Injury from a falling cylinder.
  Resulting injuries may be moderate to severe.

5 Control Measures

- Training must be received before any user is permitted to handle or use a compressed gas cylinder.
- Sturdy cylinder trolleys, preferably those with stabilising rear wheels must be supplied for transport.
- Secure racks must be provided and used for cylinder storage.
- Only those who are of physically capable are allowed to transport gas cylinders. Two people should ideally be present when transporting cylinders.
- Cylinders that are 'in use' can be stored in the laboratory in secure racks, or in exceptional circumstances in cylinder trolleys. Compressed gas cylinders must never be left freestanding.
- Back up cylinders must be stored in the goods/in-out area of the POD. Flammable gases (hydrogen) must never be stored in the same area as oxygen; a separation of three metres is required. There are two single racks at the far end of the goods in/out area of the POD for the storage of full and empty hydrogen cylinders.
- Empty cylinders should be stored separately from full cylinders. There is a rack in the liquid nitrogen room for the storage of empty non-flammable gas cylinders.
- Pressure regulators must have an annual inspection and records must be kept.
- The location of all pressurised gas cylinders must be marked on OCDEM's fire plan, a copy of which is kept by the fire panels at the main entrance and the ground floor of phase 2.
- A flashback arrestor must be used with all flammable gases.

6 Operating precautions

- Safety spectacles or a face shield should be worn when locating or removing the pressure regulator and when opening the spindle valve. Suitable closed-toe shoes should be worn to prevent crushing when moving cylinders.
- The cylinder should be checked to ensure that it contains the expected gas by examining the label and the colour code.
- The cylinder must be transported on an approved trolley by pushing and not by pulling. If the trolley shows signs of wear or damage, it must be taken out of use.
- The cylinder must be secured firmly in an approved location.
- Never open a cylinder valve unless there is a regulator head in place.
- The Pressure Regulator should be checked for the following before fitting: see figure 1
  Is it designed for the gas to be controlled?
  Is it the correct pressure?
  Is it damaged in any way? Damaged regulators must be taken out of use immediately.

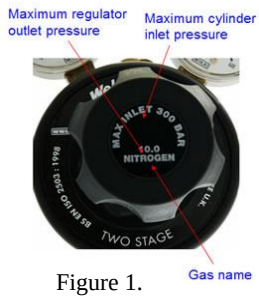

Figure 1.

- The correctly fitting cylinder spanner or key should be used when fitting regulators to avoid damage to the screw fittings. Never use a metal hammer to tighten the regulator.
- The cylinder key must be kept next to each location where cylinders are in use, in case the valve has to be closed quickly in an emergency.
- Oil or grease must never be allowed to come into contact with either the cylinder valve of the pressure regulator, especially in the case of high pressure oxygen which will react violently with oil and grease and may explode or ignite.
- PTFE tape or jointing compound should not be used to attempt to seal leaks.

- Note that flammable gas cylinders have a left hand thread.
- Leak detector spray may be used to check for leaks around the regulator.
- When fitting a pressure regulator to a cylinder the regulator should be closed by unscrewing the pressure control knob (turn anticlockwise) before opening the valve at the spindle; the spindle should be opened slowly, see figure 3.
- When a cylinder with a regulator attached is not in use, ensure that both the pressure regulator and the cylinder valve are closed.
- Cylinders must never be transported with their regulators in place.

7 Remaining Risks

These should be negligible if the precautions outlined above are followed.

8 To attach a regulator head.

See figures 2 and 3.

- Remove the plastic dust cap and check the cylinder valve outlet is free from dust and bits of plastic.
- Check the regulator as in section 6.
- Screw the regulator head onto the value outlet and tighten with a cylinder spanner, do not use excessive force; if the regulator doesn't tighten easily there is probably a fault with either the cylinder valve or regulator threads.

Figure 2

- Open the cylinder valve and check for leaks with leak detector spray or a very dilute solution of detergent. Tighten, if necessary, a plastic, leather or rubber-faced hammer may be used to turn the spanner using only light force.
- Recheck for leaks then wipe off excess spray.

9 Using the regulator.

- Double check the pressure regulator is closed before opening the cylinder valve (unscrew the pressure control knob anticlockwise until it turns freely to turn the gas flow off).
- Open the cylinder valve slowly; either by turning the spindle anticlockwise using the correct cylinder key, or turn the hand-wheel fitted on some cylinders.

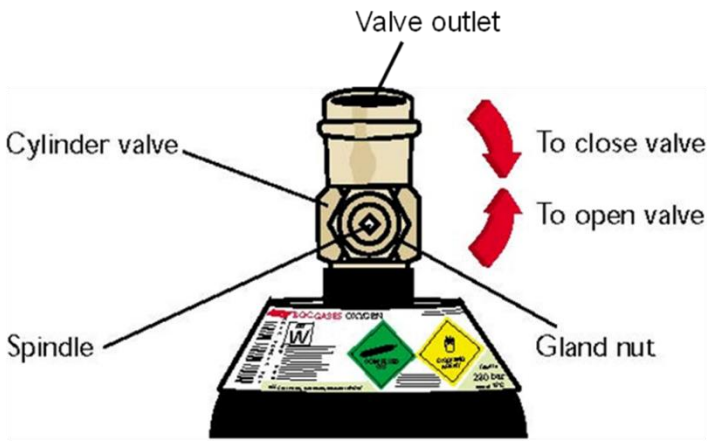

Figure 3

- An opened valve should never be left against the backstop, but should be turned back half a turn to avoid seizure in the opened position.
- Adjust the pressure regulator knob to give the desired outlet pressure.
- When a cylinder is empty, close the pressure regulator and turn off the cylinder valve by turning the spindle (or hand-wheel) clockwise just enough to stop the gas completely. Never wrench it shut.
- When the cylinder valve is closed open the pressure regulator knob briefly to allow residual gas to escape. Close it again when the pressure is at zero.

- Finally unscrew the regulator head to remove it. Place the empty cylinder in a cylinder trolley immediately for transport to the approved storage location.
- Replacement cylinders are available direct from BOC; speak to your laboratory manager for information on the correct procedure to use for ordering cylinders.

10 Life Expectancy and checking of Cylinder Regulators

- All pressure regulators must be checked on a regular basis. Those on cylinders that are changed less than once a year must be inspected once a year and every time the regulator is removed from one cylinder to another. For those gases where the regulators are removed and placed on a new cylinder on a regular basis (e.g. carbon dioxide, nitrogen), the regulators must be inspected every six months. Records must be kept.
- BOC recommend that their regulators are changed six years after manufacture. The British Compressed Gases Association guidelines recommend changing regulators every five years, but this arises from a Code of Practice for flammable gases, e.g. hydrogen and oxy-acetylene.
- The majority of pressure regulators in OCDEM are turned on and off infrequently and have very little, if any, wear and tear. With this in mind pressure regulators for inert gases do not necessarily need to be changed every five years; the period should be determined by inspection.
- Pressure regulators, and flash back arrestors if relevant, for gases that are flammable or corrosive **must** be changed every five years.
- Pressure regulators for inert, non–flammable or non-corrosive gases, can possibly be changed less frequently than five years, depending on use; the time period can be determined by regular inspections. Regulators are more likely to fail after five years and they do NOT fail safe – they fail to danger; there are several components within a regulator that are subject to wear and tear. The length of time in use must not be allowed to exceed 10 years since manufacture.

11 Emergency Procedures

- Escape of gas:
  If the gas escape is large, evacuate the area and contact the Departmental Safety Officer (DSO), Area Safety Officer or the University of Oxford Safety Office for advice; even an inert gas can kill by asphyxiation.
  For small leaks, evacuate the room and inform the DSO or a person competent in the use of compressed gases. The number of air changes in most laboratories is sufficient to clear the area within a fairly short time; the exception to this is in F45 where there is currently no mechanical ventilation.
  Do not re-enter the area until you are confident that the oxygen concentration is back up to at least 18%. If you start to feel unwell, develop a headache, feel nauseous or develop a shortness of breath, leave the area immediately and inform the DSO.
  Warning: Hydrogen leaks from a high-pressure cylinder may ignite spontaneously.
- Falling Cylinder:
  If a cylinder falls over, do not attempt to catch it. It is much too heavy and will cause serious injury. A closed gas cylinder is very robust and unlikely to be damaged through falling, although furniture or equipment the cylinder comes into contact with may be damaged. Competent help should be called to assist in setting it upright.
  The probability of a cylinder falling with a regulator attached and the cylinder valve open is extremely small but if this does occur this can cause a very serious incident

with a catastrophic release of pressurised gas. In the case of such an occurrence the area must be evacuated immediately and the instructions in 'Escape of gas' followed. Catastrophic escapes of flammable gas can be exceptionally dangerous with the risk of explosion; the fire service may need to be contacted for advice.

- There is a hydrogen detector in lab F19, which will alarm if the hydrogen concentration rises above 20% of the explosion concentration in air; a second alarm sounds at 40% of the explosion concentration of hydrogen in air. At the 40% level the area must be evacuated.

Review History

Version	Date	Reason for update	Updated/reviewed by:	Date review due
1	22/01/10	Rewritten risk assessment	Author: SMH	January 2012
1.1	Jan 2012	Review - no changes	SMH	Jan 2014
1.2	5 Feb 2014	New header added – no other changes	SMH	Feb 2016
2.0	25 May 2016	HoD and ToC added, section added on life expectancy of regulators and a new point in emergency procedures about the hydrogen detector.	SMH	May 2018