NABAS
The Balloon Association

BALLOON GAS
Facts, Figures, Safe Handling And Legislation

INTRODUCTION

Gas cylinders are used in an enormous range of activities; from industrial welding to deep sea diving, from the production of semiconductors to patient care in hospitals, from heating factories and warehouses to calibrating police intoximeters. Industrial gas companies are involved in supplying all of these applications and take great care to ensure that the cylinders you receive are suitable and safe, and will meet your requirements. It is important, however, that you understand the hazards associated with them and the steps to be taken to use them correctly and, therefore, safely. This booklet is intended to cover the basic considerations in this respect and point the way towards the safe and effective use of gas cylinders so as to protect you and your workforce.

The following text will concentrate on the commonly encountered gases in the party industry – Helium and Nitrogen. Gases for more specialised applications including toxic and highly toxic gases and gas mixtures are not covered in this booklet. Information on these can be obtained on request from your Industrial gas supplier.

Over the next few pages guidance will firstly be given on how to identify the common gas cylinders. This will be followed by consideration of hazards common to all gases in cylinders and then specific types of hazards. A description of the properties of certain gases will then be given, together with the specific precautions to be taken in each case. The text will then move on to describe the safe methods of handling cylinders, followed by recommendations for storage and a brief overview of transport considerations. A summary of precautions is then given and finally, details on where to obtain further information. A certain amount of detailed information is included in the appendices for completeness.

Gas cylinders are engineered and prepared to provide useful quantities of Helium gas for a wide range of applications. Used correctly they are quite safe, with a safety record that is the envy of many industries. Industrial gas companies are committed to ensuring that this situation continues. Please read this booklet and apply it to your workplace - it is important.

LIGHTER THAN AIR

Some history and where does helium come from?

In 1868, during observations of a solar eclipse in India, French astronomer, Pierre-Jules-César Janssen first obtained evidence of the existence of the gas when he detected a new yellow line in the solar spectrum. Sir Norman Lockyer, an English astronomer, recognised that no known element at that time gave this line and named the element helium after helios, the Greek word for the sun. It was not until 1895 that Sir William Ramsay isolated helium after treating cleveite, a uranium bearing mineral, with mineral acids. Ramsey subsequently sent samples to Sir William Crookes and Sir Norman Lockyer who finally identified the gas as helium.

Although it is found in trace quantities in the atmosphere it would be far too expensive to remove. Your helium comes from natural gas wells in the USA or North Africa where it is separated from the natural gas, collected and liquefied for transport to the UK in specially constructed road tankers. The liquefied helium is then converted back into gas and pumped into cylinders.

Yes, helium is used for balloons. From latex and mylar foil balloons for messages, decorating and balloon releases, to larger meteorological balloons carrying analytical equipment high above the earth for weather forecasting purposes.

Airships are increasing in numbers around the world. Their uses include advertising, TV platforms, surveillance, military and passenger pleasure flights. This increasing market requires helium both for initial inflation of the aircraft and top up volumes. Airships vary in size from 2,000m³ to 7,000m³ helium capacity.

The latest use for helium in the lighter than air category is tethered passenger balloons. Tethered balloons can carry up to 30 people to a height of 150 metres, each balloon requires 6,500m³ for initial inflation and top up volumes of 140m³ per month.

1 cubic metre of helium will provide 1.02 kilograms of lift.

As a guide 1 cubic metre of helium will inflate approximately 88 x 11" latex and 65 x 18" foil balloons.

IDENTIFICATION OF CYLINDERS

There is only one certain way of identifying the contents of a gas cylinder. That is by the label located on the the shoulder of the cylinder. Along with most of the existing industrial gas cylinder colours, the colour of Helium cylinders is in the process of changing,. Therefore, the colour of the cylinder cannot be used as a reliable means of identification.

In some cases there may also be stencilling or a composition label on the body of the cylinder. This is merely a further means of identification which is used for some applications and differs from the labelling or colour dose as there is no standard or legal requirement for this method.

Labels

The labels on the shoulder of the cylinder give detailed information on the gas that is contained within. The provision of this information is a legal requirement under EU chemical labelling and classification regulations and the requirement of UK and European regulations for the transport of dangerous goods. Details will be given such as the name of the gas and the the chemical formula. There will also be brief information about the hazards and necessary precautions and what are known as risk and safety phrases to indicate precautions for the safe handling and use of the gas.

Professional users of gases must also aquaint themselves with the contents of the appropriate Material safety data Sheet (MSDS) as this document will give all the information needed to make ensure the safe use of the gas and advice for emergency situations. You can obtain a copy of the MSDS free of charge from your gas supplier. Very often they can be downloaded from the company web site.

UN Numbers and Mixtures

The cylinder label will also have what is known as a “UN number” This is a number given to some chemicals by a committee of experts at the United Natuons so potentially hazardous chemicals can be quickly identied without the need to translate product names into an understandable language.

Helium UN number is 1046 Class 2.2.

If you know the UN number for a chemical you can very quickly obtain the product or chemical name and establish what hazards it may present and what precautions you need to take to make sure that you stay safe. The other useful piece of information is the “Class”. Helium is Class 2.2 which immediately indictes the gas is non-flammable and non-toxic. Other gases will be classed as 2.1 or 2.3 indicating the gas is flammable (2.1) or toxic (2.3). Since the colour bands on the cylinder shoulder do not specify this, as above, the UN number provides a useful means of determining the overall properties of the mixture. To reiterate, this label is the primary means of identification and should be read and acted upon. If the cylinder is not labelled, the contents are uknown and the cylinder must not be used or transported. It should be set aside and the gas supplier informed.

Colour Coding

Currently, industrial gas cylinders in Britain are colour coded according to the requirements of British Standard BS 349, and the actual colours used are specified in British Standard BS 381. These standards lay down specific colours for the various common gases, together with a protocol for colour coding gas mixtures. There is a general rule that red is used to denote flammability, whereas yellow is used to denote toxicity. Like most things in life, however, this is not an absolute rule and there are exceptions. All Helium supplied in the UK are currently colour coded Brown.

HELIUM - PROPERTIES

Helium is a noble gas, it is inert, colourless, odourless, non-toxic, non-flammable, non-explosive and non-radioactive. It will not combine chemically with any other element. Helium is unique in that it combines, inertness, high thermal conductivity, low boiling point, lightness and small molecular size, properties that are normally associated with many industrial gases. Because of this its uses and applications are many. Helium is the lightest of the inert or noble gases.

Helium also has the lowest boiling point, 4.2°K (-268.8°C) of any element. This property makes liquid helium useful as a cryogenic refrigerant and essential in superconductivity applications.

Table 1 - Specific Properties of Helium

Molecular Symbol	He
Molecular Weight	4.0026
Boiling Point (1 atm)	4.2°K (-268.8°C)
Boiling Point	0.125 g/cm³ 124.9 g/l
Gas Density at Normal Boiling Point	0.01689 g/cm³ 16.89 g/l
Gas Density at NTP (1 atm & 70°F)	0.1657 g/l 0.01034 tb/ft^3
Gas Density at STP (1 atm & 0°C)	0.1785 g/l 0.01114 tb/ft^3
Latent Heat of Vaporisation at Normal Boiling Point	4.88 cul/g 20.4 joules/g 609 cul/l 8.78 Btu/lb 2.42 Btu/l
Thermal conductivity of gas at NTP	1.53 milliwatts/cm^2 0.088 Btu/hr, ft^2
Thermal conductivity of gas at STP	1.45 milliwatts/cm^2 0.084 Btu/hr, ft^2
Volume expansion, Liquid at NBP to Gas at NTP	753.8 to 1
Volume expansion, Liquid at NBP to gas at STP	699.7 to 1

GENERAL HAZARDS OF GAS CYLINDERS

By way of introduction into the hazards of specific gases, it is useful to review some general properties of any gas which might lead to injury to anyone coming into contact with them. These properties include the pressure of the gas inside the cylinders and its ability to expand quickly to very large volumes.

Pressure

Firstly, to be of any practical use cylinders need to contain a significant quantity of gas compressed to as high a pressure as possbile. By simple laws of physics, the higher the pressure the smaller the volume occupied by the gas, hence the smaller and more manageable the cylinder can be made. In the last twenty years there has been an increase of approximately 60 per cent in the amount of gas put into cylinders. Stored pressures of 300 bar (over 4,500 psi) are now becoming commonplace.

There is thus a great deal of stored energy inside the thick walls of the gas cylinder - energy which is very useful to the operator, but needs to be controlled to prevent it causing harm. In particular, gases released from a cylinder whether by controlled opening of the valve, shearing of the valve or through a leak, can have a very high velocity. It is estimated, for example, that should the gas be released suddenly from a modern high pressure cylinder, the resulting force would be sufficient to accelerate the cylinder to a speed of 35 miles per hour in a tenth of a second! It is also possible that dust particles or debris from the working area, may become entrained in the gas flow and cause injury to the eyes, face or other parts of the body.

Expansion

Secondly the volume of gas stored under pressure within a cylinder will occupy much larger volumes when expanded to atmospheric pressure. It is important to realise the potential this volume of gas might have for displacing breathable air, or creating an explosive atmosphere at the work place. The majority of gas companies fill cylinders to 200-300 bar. The gas contained in a 50 litre cylinder compressed to 200 bar will fill a space 8.5 cubic metres in volume if it were all released to atmosphere.

Cooling Effect

Finally, when gas under pressure in a small volume expands rapidly to a lower pressure, it takes in heat energy from the surroundings. This principle is used very effectively in refrigeration systems. Although it makes for a very interesting scientific experiment, it can lead to serious problems for the unwary user, since in some circumstances the heat drawn from the metal in valves and regulators can cause them to freeze and frost up. If these metal parts are then touched, frostbite and cold burns can be caused which are very painful and difficult to treat. This sort of situation can occur if a valve is left cracked open or a valve failure develops. Anyone who has filled a gas-fuelled cigarette lighter can attest to the cooling effect of gas expansion!

GENERAL PRECAUTIONS

The Gas

Armed with the information given earlier, it is essential that all users of gases identify the contents of cylinders before attempting to use them and have ready the label to familiarise themselves with the hazards and precautions necessary.

Valves and Pressure Regulators

It is also essential that users understand how to operate cylinder valves, pressure regulators and any other equipment supplied for use with the cylinder. This may sound simple but it is amazing how many incidents result from a lack of understanding of how to shut off a valve or close down a regulator.

All British cylinder valves are closed by turning the valve clockwise and are opened by turning it anti-clockwise.

Regulators are shut off by screwing them out (that is anti-clockwise). Screwing them in (that is clockwise) raises the pressure.

Valves should never be closed with such force that they require undue leverage to open. If a valve is difficult to seat adequately without applying a high torque, set the cylinder aside, mark clearly "DO NOT USE" and notify the gas supplier.

The Application

As well as understanding the properties and characteristics of the gas being used, how to get the gas out of the cylinder safely (and how to keep it in when necessary), users must have a good knowedge of the application itself. Although many DIY enthusiasts are casual users of the gases, they use them at their own peril if they do not carefully study the available data and safety sheets for the gases and the instruction manual supplied with the equipment. All gas and equipment suppliers should provide literature and suitable training material for operators and there are many Industry and Government sponsored courses available for a range of applications.

Gas Properties and Characteristics

Every gas has to be supplied with a Material Safety Data Sheet which details the chemical and physical properties and characteristics of the gas; as well as providing advice on use, handling, storage and transport. Any limits for safe use are also detailed. All users must ensure that they are familiar with the information contained in these sheets for the gases they are using.

Personal Protection

The most likely cause of a sudden release of gas at high pressure from a cylinder is the valve shearing off as a result of impact, since the valve is the most vulnerable part of the cylinder. It is for this reason that the majority of cylinders supplied by gas companies are fitted with valve protection guards, which must be in place before attempting to handle and move the cylinders.

In order to protect against two of the general characteristics mentioned earlier, namely high pressure and possible low temperature created by escaping gas, users should always wear some sort of personal protection when handling or using gases.

Safety glasses or goggles, approved to BS 2092 should be used to protect the eyes from high velocity gases or particles carried in the gas stream. Gloves or gauntlets should be worn to proect the hands from cold burns and other injuries. Protective footwear should be worn to avoid injury from falling cylinders. Clothing should be made from highly combustible materials particularly when using Oxygen or fuel gases. Additional protective clothing may be required in awkward work locations.

HAZARDS OF HELIUM

Helium is odourless, colourless, is non-toxic and is much lighter than air. It is inert and will not burn or support combustion. It is however, a simple asphyxiant and in high concentrations it will displace the oxgen in the air when it will give rise to a risk of asphyxiation. Under no circumstances should Helium be inhaled.

Helium cylinders are currently colour coded BROWN.

CYLINDER HANDLING

Throughout industry manual handling accounts for over a third of reported accidents. Common injuries experienced include slipped discs and other back injuries such as sciatica, strained muscles and torn ligaments as well as associated types of injuries as a result of contact with the materials being handled.

It was in an attempt to combat this trend that the Manual Handling Operations Regulations 1992 were brought into effect. These regulations oblige employers to remove or at least reduce the necessity for manual handling, or if this is not possible, to assess the risks and implement suitable safety measures. The HSE subsequently produced guidance on the regulations.

Users of industrial gases face particular issues in this respect. A large cylinder (50 litre water capacity) can weigh anything between 60 and 100 kilograms, and is a relatively unstable mass of metal. They are designed for a particular task - containing the maximum amount of gas in the smallest practical package. Given this primary purpose they are not the easiest of objects to handle or move. Many injuries have followed from poor methods of handling and the misuse of cylinders has caused injury and damage to property.

Preferred Method

The easiest, safest and therefore the best way to handle and move gas cylinders is with the help of mechanical aids. These range from specially designed vehicles for transporting them, through fork lift trucks for loading and unloading them, to cylinder trolleys for moving them around. The use of these devices is in line with the requirements of the regulations to 'automate' handling if the need for it cannot be removed.

In the case of single cylinders, it is often more appropriate to use devices such as tail lifts, whereby cylinders can be churned onto the platform and lowered to the ground. Manually dropping cylinders onto the ground, or the reverse action of attempting to manually lift cylinders onto the deck of a vehicle are to be avoided at all costs. Such actions can result in serious strains and sprains, or damage to the cylinders with consequent risks.

The last, but not least, mechanical aid to mention is the cylinder trolley. This again is a purpose designed device which usually holds one cylinder at a time, secured by a chain to prevent it from falling out. It provides the safest method of moving cylinders around premises, in particular where the user is inexperienced in handling cylinders or where the ground is uneven.

Churning

During the handling of cylinders it is almost inevitable that at some point the cylinder will have to be moved by hand. This could be when moving it around a room, moving it into position on equipment or where a cylinder trolley is not available. This is an acquired art but some guidelines can be given here.

Churning cylinders requires the use of both hands. One hand holds the top of the cylinder on the valve guard to steady and support it, whilst the other imparts a rotary motion to the body of the cylinder, thereby spinning it along the ground on its axis. It is important to lean the cylinder over from the vertical by just the right amount while doing this. Leaning it over too far can result in the cylinder spinning out of control, while not leaning it over far enough will make it difficult to make any progress. It is recommended that protective footwear (with steel toe-caps) and suitable gloves are worn whilst doing this to protect against impact on the feet from the cylinder and trapping fingers respectively. The distance that cylinders are churned should be kept to a bare minimum.

One of the hazards of handling cylinders concerns the risk of injury should the cylinder fall or be knocked over. Care should be taken to prevent this from happening, but the general advice here is that if a cylinder does start to fall over, do not try to catch it. Stand clear and let it fall. Serious back injuries have resulted from attempting to catch falling cylinders, the weight of which can be equivalent to that of a large person. Under the vast majority of conditions, it is unlikely that the cylinder will come to any harm and the valve should be protected from shearing off by the valve guard.

If a cylinder has fallen over there is a safe method for picking it up, especially in the case of the largest cylinders. Approach the cylinder and crouch at the top (valve end) of the cylinder, facing down the cylinder body. Adopting a balanced posture, check that the valve is closed and the valve guard is securely attached. Grasping the valve guard, straighten the back, lift up and at the same time slowly rise from the crouching position and walk forward until the cylinder has been raised to the vertical. Steady the cylinder and ensure that it is stable before leaving it.

From the above, it is clear that only one cylinder at a time should ever be churned. It is impossible to properly control more than one cylinder at a time, however impressive it may look. If a cylinder has to be lifted a small amount, e.g. onto a pallet, it is recommended that a suitable mechanical aid or, failing this, a short ramp is used, rather than trying to pick up the cylinder.

Cylinders should never be deliberately dropped or hit sharply. They should also never be used for any other purpose, e.g. as supports or rollers. They should never be rolled horizontally along the ground as damage can be caused and the cylinder markings obliterated. They should also never be allowed to come into contact with an electrical supply or electrical equipment. Direct heat or flames should never be used on them and they should be adequately protected from these at all times. Finally, cylinders should never be hoisted by the valve guard - this is designed to protect the valve not as a lifting handle.

STORAGE OF GASES

This is a potentially complex subject, given the variations in types of premises and the mix of gases being stored. Without full details on these issues, only the sort of matters that need to be covered can be addressed. Any further guidance would have to be on an individual basis.
The chief concerns of any facility for storing gases relate to the control or elimination of the hazards presented by flammable, oxidising, asphyxiating and toxic gases.

General

The storage facility should be in the open wherever possible. Storage inside buildings presents many potential problems relating to ventilation, flammable zone ratings etc, most of which can be avoided by storing the gases in the open air.

The facility should be secure, sufficient to prevent unauthorised access as far as practicable. Where possible a perimeter fence to a height of 1.8m is recommended. For fenced compounds adequate means of access and escape should be provided, usually entailing the provision of two exits, with any gates opening outwards. The cylinders should be stored on a flat, firm surface, preferably concrete as an impermeable medium. This surface should be adequately maintained so as to provide a stable base for the cylinders. The storage surface should be adequately drained to avoid the cylinders standing in water which would lead to corrosion of the cylinder bases. If stored adjacent to buildings avoid proximity with doors and gangways and especially in the case of lighter than air gases - windows and other openings.

Good housekeeping is important. Separate full cylinders from empty and avoid the accumulation of rubbish etc, particularly combustible materials.

Particular Gases

Individual gases have individual storage requirements, which are mentioned below.

Helium, Argon, Nitrogen, Carbon Dioxide

These are classed as inert, or relatively inert gases and so can be stored adjacent to most other gases if required. The main hazard presented by these is as an asphyxiant due to their ability to displace breathable air in an enclosed space.

TRANSPORTATION OF GASES

There is a plethora of legislation covering the transportation of gases, much of which is common to all products classed as hazardous. Such legislation specifies the method of transportation, the safety requirements for various quantities and the information that must accompany the load. Some of the basic requirements will be covered here.

Transporting gas cylinders by road – The ADR Regulations

In the UK, the road transport of dangerous goods in governed by an EU wide standard known as the ADR. This 1200 page document covers all the legal requirements that must be observed by the carrier of dangerous goods.

The good news is that for most helium users, because the quantity of gas being carried is very small, the journey will be exempted from the regulations under clause 1.1.3.6 in ADR. This is usually called “the thousand points rule”. Basically, this states that if the quantity of goods carried is below a certain threshold, apart from taking reasonable care to ensure the load is secure, the need to show orange plates or green hazard diamonds on your vehicle, carry TREMCARDS, etc., etc. does not apply.

In effect, you are allowed to carry 1000 litres of helium, or any non-flammable, non toxic gas, before the rules apply. That means you would need to have over 20 cylinders of 50 litre capacity, on board your vehicle.

It may be “good practice” to put a green diamond on the back of your vehicle to advise the emergency services in the event of an accident, but remember to remove it when you are not carrying any cylinders.

When you are carrying cylinders, please follow these simple but important guidelines.

- Ensure the valve is closed
- Disconnect any regulators or balloon adapters and re-check the valve is closed.
- Stow the cylinder securely so that it cannot move forward in the event of emergency braking
- Ensure adequate ventilation in the vehicle
- Always take care when lifting – cylinders are heavy!

If you want to know more about the ADR regulations, please follow this link: www.hse.gov.uk/pubns/cdg.pdf

More details can be found in the BCGA bulletin included in the appendices.

The responsibility for supplying information where required rests with the supplier or 'consignor' of the gases. This could be the original gas producer or an agent if cylinders are being sold on. The responsibility for complying with the requirements imposed according to the quantity being transported rests with the carrier, although the gas companies are always willing to supply advice.

FURTHER INFORMATION

The primary sources of further information about the storage, handling and use of gases are the Codes of Practice published by the British Compressed Gases Association (BCGA). Their address is as follows: British Compressed Gases Association, 14 Tollgate, Eastleigh, Hampshire SO5 3TG Tel: 01703 641488

Also of note are similar Codes of Practice from the European Compressed Gases Association (EIGA).

Specific information on the hazards and precautions for particular gases appear on the Material Safety Data Sheets supplied with each product. It is a legal requirement for suppliers to provide their customers with copies of these on the first purchase of each gas and to supply any updates if the customer has purchased the gas in the previous twelve months.

TREMCARDS carried with the gases during transportation provide emergency advice.

The Health and Safety Executive publish various documents, some of which are relevant to the area of gases. Of particular note is HS(G) 71 which deals with 'Packaged Goods'.

Last but not least, in terms of information sources is the supplier. The gas company will always endeavour to provide specific information and answer any queries the customer may have to promote the safe and effective use of industrial gases.

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