SAFETY FEATURES OF PORTABLE CRYOGENIC LIQUID CONTAINERS FOR INDUSTRIAL AND MEDICAL GASES

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- LABELLING
- SAFETY

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1 Introduction

A nursing home ordered four liquid cylinders with medical oxygen but received mistakenly one filled with industrial nitrogen together with three filled with medical oxygen. A maintenance employee at the nursing home was asked to connect a new oxygen vessel to the oxygen supply system. He selected the nitrogen vessel not observing the text of the label and tried to connect it to the oxygen supply system. He failed since the connectors were not compatible. He then removed a fitting from an empty oxygen liquid cylinder, installed it on the liquid nitrogen cylinder and then connected the nitrogen cylinder to the medical oxygen supply system. Four patients suffered asphyxiation and died as a result of breathing the nitrogen.

The above accident and similar ones have initiated a strong focus around safe use of portable cryogenic liquid cylinders for medical and non-medical applications. It is strongly recommended that each AIGA member company ensure that the appropriate customers receive this information and, if needed, further training in the handling of medical gases and associated equipment. Special attention should be paid to the fact that a contributing cause to several incidents has been the mix-up of medical and industrial gases at the delivery to the medical gas customer.

2 Scope

The scope of this Safety Info is the external safety features of portable cryogenic containers within the range of above 0.5 bar(g) pressure and a net liquid capacity no greater than 1,000 litres, but excluding “Home Care” portable cryogenic containers.

3 Safety features

3.1 External contamination

External contamination may occur while containers are in use, in storage or during transportation. Atmospheric pollutants and other contaminants such as oil, particulate matter, etc. can create potential hazards where oxidizing gases are involved – especially liquid oxygen - and react with explosive violence. Therefore, it is recommended that such containers are thoroughly inspected before filling and that all control and safety devices are kept clean and free of any hydrocarbon substances. This is to ensure safety and integrity of the package. All pre-fill inspections must be carried out as specified. Containers that fail during pre-fill examinations shall be identified, quarantined and removed from service. Things to generally check for during a pre-fill inspection are:

a. Cylinder marking (check for cylinder specifications, ownership, service pressure, serial number, tare weight, manufacture date etc)
b. Labelling (check for current and legible product label)
c. Surface contamination (check for foreign substance e.g. grease, oil etc)
d. Surface damage (check for large dent, fire damage, and any other surface damage)
e. Mechanical damage (check for damage to foot ring, wheels, etc)
f. Valves (check for contamination, damage and any missing parts. Also verify that gas, liquid and vent connections are correct for the service)
g. Relief devices (check the pressure relief device to ensure correct rating, the discharge port is free from blockage and there is no sign of damage etc)
h. Cylinder hardware (check cylinder top works, content gauge, pressure gauge, regulators etc are in order and there are no damage signs or no part is lost)
i. Carry out odour test if required per specific policy and need. This should be done by competent people only
j. Record keeping (document the pre-fill inspection on an appropriate quality record)

3.2 “Back Contamination” from the Consumer’s Process

In order to protect against contamination it is essential that equipment is installed within the consumer’s fixed supply system that will prevent such an occurrence for example by the installation of

non-return valves. Such a device should be adequately sized and specified to accommodate the pressure range that the container, and/or the consumer's supply system, will operate within.

3.3 Pressure in Excess of Design Pressure

Containers can be utilised within process systems where pressures in excess of the container's design parameters can occur. Examples are: compressed gas cylinders, pressure swing absorber systems and membrane systems. It is critical that adequate safeguards are incorporated within the design of any process system utilising gaseous product from the container.

- A relief device set at the design pressure of the cryogenic liquid container and capable of discharging the maximum flow achievable from the high pressure source, should be installed between the liquid container and the high pressure source.

- A pressure reducing valve should be installed between the high pressure source and the cryogenic liquid container that is capable of controlling a down stream pressure below the design pressure of the cryogenic liquid container.

3.4 Liquid and Gaseous Connections

Connections utilised for liquid cylinders should eliminate the potential for incorrect filling, or product withdrawal from cryogenic liquid container by using connectors specific either for each gas or for each type of gas such as the same connection for the inert gases argon and nitrogen.
See AIGA 019/05 - Connections for portable liquid cylinders

3.5 Modification to Liquid and Gas Outlet Connections

To protect against unsafe conditions arising from the filling of a container with an incorrect product, and the potential impact of product integrity being compromised, the following procedures should be adopted for all liquid, and gas, withdrawal and filling connections of cryogenic liquid containers.

- Use of coupling adapters shall be strictly prohibited.

- A controlled procedure must be developed and implemented, that ensures only authorised and competent personnel undertake any modifications to liquid and gas connections on a cryogenic liquid container owned/operated by the responsible filling company. These modifications are done under the responsibility of the gas filling company and records must be maintained of all changes of service.

- **Medical** liquid cylinders**.** the outlet shall be either:

  - a threaded or socket connection, silver brazed, welded, or attached by other methods to the valve body in a manner that prevents removal or would render the connection or valve body outlet unusable if removal was attempted or accomplished;
  or:
  - a permanent and integral part of the valve body.
  For containers used in fixed installations the connections can be permanently fixed when the container is next refurbished.

- **Industrial** liquid cylinders shall have any of the above outlet connections or a threaded connection with a device that deters removal of the fitting and provides indication that removal was attempted.

3.6 Identification and Labelling

It is recommended that the following labels are securely affixed to the body of the container in addition to any statutory requirements.

- Clear product identification which can be easily read at a safe distance and comply with the guidelines for the labelling of gas cylinders.

- Additional product labels should be securely affixed at the inlet and outlet connections

- To further increase the product identification, a label visible from all directions may be fixed on the cylinder.

- Actions to be taken by the user's personnel in the event of an emergency should be simply and clearly displayed

3.7 Storage of gases

Clearly separated and marked storage areas should be provided at filling plants, sales outlets and customers for medical and industrial gases.