SAFETY INSTRUCTIONS FOR ALL PRESSURELESS CYLINDRICAL DEWAR FLASKS AND CRYOGENIC CONTAINERS OUT OF GLASS AND METAL FOR THE USAGE OF LIQUID NITROGEN

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1 IN GENERAL

This document contains general safety instructions in general, when using with liquid nitrogen.

The following instructions shall be respected while working with liquid nitrogen. To minimise the risk of accident and their consequences a few precautions should be taken, particularly related to:

- Oxygen deficiency
- Cryogenic burns
- Risks of explosion
- Oxygen enrichment

Once the users have been informed of risks and environmental conditions, all of them must be able to use liquid nitrogen in a safe way.

2 SAFETY INSTRUCTIONS

2.1 OXYGEN DEFICIENCY

The approximate composition of air by volume is as follows for its main components:

Oxygen O_2 21 %
Nitrogen N_2 78 %
Argon Ar 1 %

This gases are not toxic, but changes in their relative constituents, and particularly oxygen, have an effect on life and combustion processes. Therefore it is essential that the air we breathe should contain sufficient oxygen (> 19 %).

Our senses are incapable of detecting changes in the concentration of the constituents of air sufficiently quickly, since they are odourless and colourless.

2.1.1 Dangers

The risk of suffocation is high due to normal evaporation of liquid nitrogen to nitrogen gas that displaces oxygen in the inhaled air. For example, under standard temperature and pressure conditions (20° C; 1013 mbar), 1 litre of liquid nitrogen evaporates to 680 litres of nitrogen gas. The critical limit of oxygen can be easily reached.

Oxygen deficiency is dangerous and can cause death from suffocation.
The reaction of the organism to oxygen deficiency is different from one person to another. It is impossible to give any valid information in general about symptoms of a starting oxygen deficiency.

2.1.2 Causes

To protect yourself from risks of oxygen deficiency pay attention to following points:

- usage of liquid or gaseous nitrogen
- natural evaporation of liquid nitrogen
- refilling of liquid nitrogen
- leaks in storage tanks for liquid or gaseous nitrogen
- defective vent pipes or exhaust pipes
- tipping over the vessel

This list is not complete.

2.1.3 Recommendation

Proceed as follows to prevent the risks of oxygen deficiency:

- keep always the vessel in the vertical position
- close the vessel with an suitable lid
- do not put the vessel in bright sunshine or close to a heat source
- do not transport the vessel by car
- premises must always be well ventilated
- prevent strokes, avoid shocks and sudden movements
- wear always individual protective equipment (suitable gloves, safety goggles or protection visors and closed shoes)
- check the oxygen content continuously
- carry an oxygen meter
- train personnel

This list is not complete.

2.1.4 General behaviour to be followed in case of accident

Proceed as follows:

- mark the environment to prevent secondary accidents
- take action quickly: the rescuer must have taken individual protective measures (independent breathing protection apparatus)
- move the victim(s) away as quickly as possible
- pay attention to internal first aid rules of your plant
- ventilate the room sufficiently
- find out the reason of accident

This list is not complete.

2.2 CRYOGENIC BURNS

Liquid nitrogen is extremely cold (-196° C)

Parts of vessel that have been in contact with liquid nitrogen (especially while refilling) can burn the skin in case of contact.

2.2.1 Danger

Cryogenic fluids can:

- cause burns on the human body
- make materials (metallic or plastic) brittle in case they are not suitable for low temperatures
- cause strong nebulosity, depending on the air humidity of premise

2.2.2 Causes

There are two kinds of cryogenic burns:

2.2.2.1 Burns by splashes

It is important to protect yourself against the risk of splashes while using liquid nitrogen, especially when handling with samples. Splashes can cause cryogenic burns that can have serious consequences, especially when hitting eyes or face.

2.2.2.2 Contact burns

Contact between skin and cold materials causes frostbites or cryogenic burns. Never touch or grip the inner side of vessel or samples with a bare hand.

2.2.3 Recommendation

Proceed as follows to prevent the risks of burns:

- prevent skin contact with cryogenic liquids
- never touch the cold walls of vessel, or un-insulated or frosted equipment
- wear individual protection equipment (suitable gloves, safety goggles or protective visors and closed shoes)
- always hold the vessel in the vertical position
- use only suitable equipment (metal or PTFE hose) for refilling the container
- train personnel

This list is not complete.

2.2.4 General behaviour to be followed if liquid nitrogen is splashed

2.2.4.1 In the eyes
- wash the eye with a generous supply of water for at least 15 minutes
- pay attention to internal first aid rules of your plant
- consult a doctor

2.2.4.2 On the skin
- do not rub
- if possible, remove or loosen your cloths
- defrost affected parts by moderate and progressive heating
- do not apply anything on the burned area
- pay attention to internal first aid rules of your plant
- consult a doctor

Both lists are not complete.

2.3 THE RISK OF EXPLOSION

2.3.1 Dangers

The evaporation of liquid nitrogen can causes an overpressure inside of the vessels.

2.3.2 Causes

The increase of pressure in the vessel may happen due to:

- poor maintenance of the container
- accumulation of ice on the neck and the lid

This list is not complete.

2.3.3 Recommendation

Proceed as follows to prevent the risk of explosion:

- always use a suitable lid (pay attention to an exhaust gas opening)
- respect filling levels to prevent the formation of ice on the lid
- use the vessel only in dry and sheltered locations
- control the humidity of the room
- check vessel periodically with regards to accumulations of condensation water
- check vessel periodically with regards to surface defects and material damages

This list is not complete.

2.3.4 General behaviour to be followed in case of accidents

Please see above under 2.1.4, oxygen deficiency.

2.4 OXYGEN ENRICHMENT

2.4.1 Dangers

Oxygen enrichment can enlarge the risk of explosion or fire.

2.4.2 Causes

Oxygen enrichment, as a result of liquefaction of ambient air, can occur, because the boiling point of oxygen is high (-183° C) than the boiling point of liquid nitrogen (-196° C).

2.4.3 Recommendation

Proceed as follows to prevent the risk of explosion in case of oxygen enrichment:

- do not smoke
- eliminate easily inflammable products from the area of vessel, if possible
- eliminate all sources of fire (flames, sparks, matches, lighters, etc.)
- premise of vessel must be continuously and adequate ventilated
- clean the floor regularly
- train personnel
- wear individual protection equipment
- check the oxygen content continuously
- always wear an oxygen meter

This list is not complete.

2.5 ENVIRONMENT OF VESSEL

2.5.1 The premise

The premise of vessel shall:

- enable safe operation for participants
- enable a safe refilling of vessel
- be continuously and adequate ventilated
- have a flat and non-porous floor, capable of resisting the maximum load of vessel
- include posters (safety data sheets) mentioning the dangerous properties of liquid nitrogen
- prevent access to unauthorised persons
- enable a good accessibility of vessel for inspection, cleaning and maintenance

This list is not complete.