CRYOGENICS SAFETY

Introduction

Cryogenics is the science of ultra low temperatures.
Low temperatures are achieved by the liquefaction of gases.

The gases which are most widely used in industry and research are helium, hydrogen, nitrogen, fluorine, argon, oxygen and methane.

Properties of cryogenic fluids

- Extreme low temperatures.
- Large ratio of expansion in volume from liquid to gas.
- Most cryogenic liquids are odourless and colourless when vapourised to gas.

Properties of cryogenic fluids

Boiling points of cryogens

- Helium - 269.9 ^{0}C
- Hydrogen - 252.7 ^{0}C
- Neon - 245.9 ^{0}C
- Nitrogen - 195.8 ^{0}C
- Oxygen - 183.0 ^{0}C

Liquid to gas expansion ratios of cryogens

- Helium 1 to 757
- Hydrogen 1 to 851
- Neon 1 to 1438
- Nitrogen 1 to 696
- Oxygen 1 to 860

Storage

- Cryogenic fluids are stored in well insulated containers to minimize loss due to boil off.
- The most commonly used container for handling cryogenic fluids is the Dewar flask.
- Dewar flasks are non pressurized, vacuum jacketed vessels.

Containers for storing cryogens

Potential hazards

Potential hazards in handling cryogens are

- They displace oxygen in non ventilated confined spaces causing oxygen deficient atmosphere.
- On contact with skin, they can cause frost burns due to extreme cold.
- Pressure build up in the container can cause explosion.
- Affects properties of materials.
- Oxygen enrichment

Oxygen deficiency

- Cryogens can displace oxygen in enclosed spaces resulting in asphyxiation.

- A work space is considered unsafe for entry if the oxygen level falls below 19.5%.

Oxygen deficiency

Precautions

- Cryogenic liquids must be handled in well ventilated areas to prevent excessive concentrations of gas in enclosed spaces.

- The gas released from equipment must not be disposed of in confined/enclosed areas.

Oxygen deficiency

Precautions

- Oxygen level detectors to be installed in enclosed spaces where there is chance of build up of gases causing oxygen deficiency.

Frost burns

- Contact with cryogens (liquid and vapour) can cause burns similar to that caused by high temperature thermal burns.
- Cryogens can cause embrittlement of the exposed body surface because of high water content of the human body.
- Splashing of cryogens can result in permanent eye damage.

Precautions during handling

- Keep safe distance from boiling and splashing liquid and its issuing cold gas.
- Boiling and splashing occur when charging a warm container or when inserting objects into the liquid.
- These operations must be performed slowly to minimize boiling and splashing.

Precautions during handling

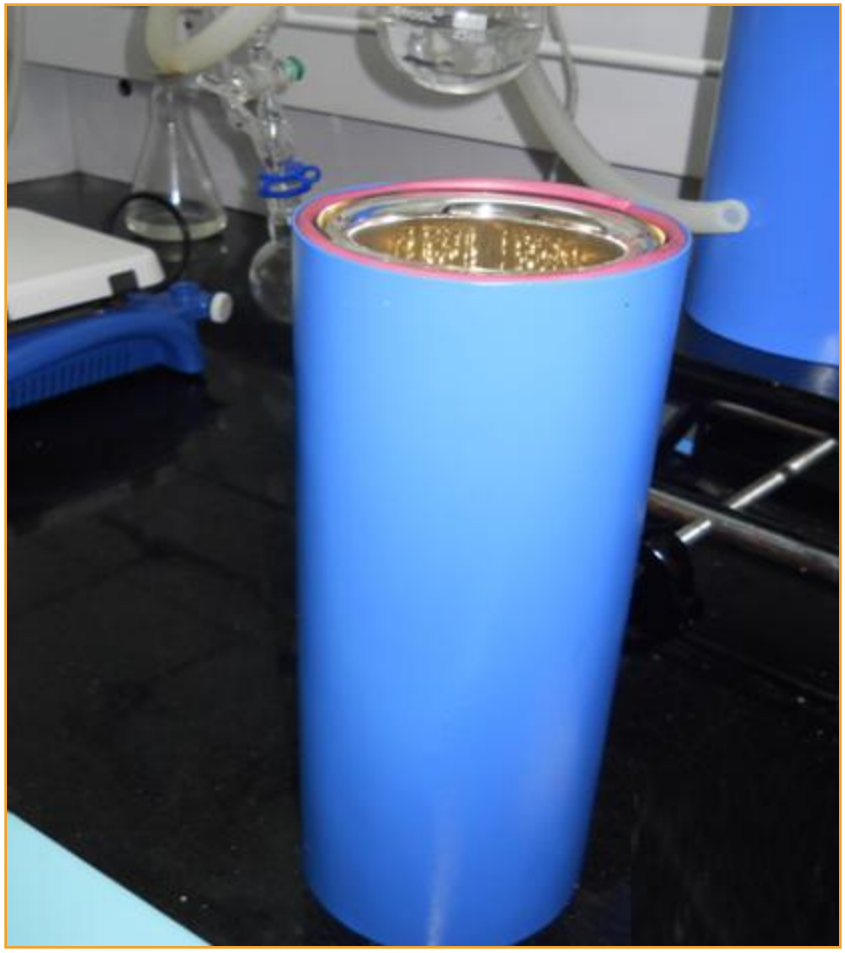
- Any unprotected part of the body must never be allowed to touch uninsulated pipes or vessels containing liquefied gases.
- The extremely cold metal can stick fast and tear the flesh, if an attempt is made to withdraw from it.
- Liquefied gases must be transported only in suitably insulated containers that provide means for the escape of gas as liquid evaporates. Never plug the outlet of such containers.

Precautions during handling

- When pouring liquefied gases from one container to another, the receiving container must be cooled gradually to prevent thermal shock.
- The liquid must be poured slowly to avoid spattering.
- A discharge tube must be used when it is not safe or convenient to tilt the container or to remove liquid from large 50- or 100-litre containers.

Precautions during handling

- Cryo flask for handling liquid nitrogen



Precautions during handling

- Portable trolleys must be used for moving large containers of cryogens.

Precautions during handling

- Cryogenic containers must not be dropped or tipped on their sides.

- Frost spots may appear in case of loss of insulating vacuum. A vessel in this condition must be removed from service. Repairs must be handled by the manufacturer.

Precautions during handling

- Prevent the entry of liquid cryogen inside the glass vials while inserting the same inside the container. As later the liquid can expand causing the explosion of the vial.

- Tongs must be used to withdraw objects immersed in liquid.

Protective equipment

- Safety glasses and face shield should be used for eye and face protection.

Protective equipment

- Cryo hand gloves must be worn when handling cryogenic liquids.

- The gloves must be loose fit so that they can be quickly removed in case any liquid splashes into them.

Protective equipment

- Aprons must be worn to protect the body from splashing.
- Open toed footwear not to be worn while handling cryogens as they won’t offer protection incase of spill of the liquid.
- Watches, rings or any other item must not be worn that could trap the liquid in case of a spill.

Pressure hazard

- Usage of cryogens always present a high pressure hazard as the gases are stored at or near their boiling point.

- The liquefied gas will be evaporating continuously into the gaseous state and as a result there is always some gas present in the container.

- The large expansion ratio from liquid to gas provides a source for the build up of high pressure in the container.

Pressure hazard

Precautions

- Dewars must be kept covered with a loose fitting cap to prevent air or moisture from entering the container, and to allow build up pressure to escape.

- Make sure that no ice accumulates in the neck or on the cover and causes a blockage and subsequent pressure buildup.

- Only containers specifically designed for holding cryogenic liquids must be used.

Material hazards

- Ordinary carbon steels and most alloy steels, rubber becomes brittle when subjected to the low temperatures of cryogens. These materials are considered unsuitable for use with cryogens.

- Metals which are suitable for cryogenic temperatures are copper, brass, bronze, monel and aluminium.

Oxygen enrichment

- When liquid nitrogen is transferred through uninsulated metal pipes, surrounding air can condense on it.
- An oxygen-enriched condensate is formed on the surface as nitrogen evaporates, increasing the flammability of materials near the system.
- Combustible materials must be stored clear of equipment containing cryogenic fluids to reduce the risk of fire.

Handling liquid helium

- Air liquifies and solidifies readily when exposed to the extremely low temperature of liquid helium.

- If solidified gases are allowed to form and collect, they may plug pressure relief passages and relief valves.

- The fill and vent ports of storage containers must be kept closed at all times (except during filling) to prevent blockages from forming in the exit passage and a resultant pressure build up.

Handling liquid helium

- Always store and handle liquid helium under positive pressure or in closed systems to prevent the infiltration and solidification of air or other gases.

- Cylinders whether full or empty must not be subjected to rough handling.

- In case of spill of large quantity of fluid, evacuate the area.

THANK YOU