Safety guidelines for working with cold media

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1 INTRODUCTION

Working with cold media implies a number of specific safety risks. The products concerned are basically nitrogen, oxygen, argon and helium. By taking into account the characteristics of these products in a cold condition, and to realise what effect they have on humans and their environment, the chances of an accident can be minimized. The information which follows enables you to identify the dangers and shows you how you can protect yourself and others.

2 COLDNESS

The liquids most frequently used in the industry at low temperatures are liquid oxygen, nitrogen, argon and helium. Oxygen, nitrogen and argon are liquids from approx. -186°C while helium is liquid from -269°C. Exposing the body to products with such a low temperature leads to freezing of tissue and so called cold burns.
Cold burns can also occur when touching un-insulated machines and piping through which these extreme cold products are flowing.

2.1 Steps to be taken in case of an accident

1. The frozen tissue must be defrosted as soon as possible. This can be realized by submerging the frozen body part in water with a temperature of 40°C until it has regained its original colour.

   NOTE: In case clothing is frozen onto the skin, NEVER TRY TO REMOVE THIS CLOTHING! By doing that, also the skin below it will be removed. The skin acts as protective layer, even if frozen!

2. Bandage the burnt part with sterile dressing.
3. Consult a doctor.

Breathing the extremely cold vapours that can be released with liquid products at low temperatures can lead to freezing of the bronchi and the lungs. If one has been exposed to this, a doctor must be contacted immediately.

If one has been exposed to cold during a prolonged period of time, hypothermia can occur. In such a case the victim must be wrapped in a warm blanket before being transported to a hospital.

Should a splash of a cold product end up in the eye, medical assistance must be called immediately.

2.2 Precautions

Many of the problems described above can be prevented by taking the correct precautions such as:

1. Screening off those areas in which work is performed with extremely cold products.
2. Wearing protective clothing with which the body is covered to a maximum, wearing leather work gloves and safety glasses.

2.3 Influence on materials

Other materials that become extremely cold due to e.g. leaking liquids, can become hard and brittle and break, becoming as sharp as glass. Concrete exposed to low temperatures for a prolonged period of time can disintegrate and turn to powder.

Carbon steel becomes brittle at temperatures lower than -20°C, and applications of these materials must be avoided in such situations as much as possible.

Plastics and rubbers become hard and brittle at lower temperatures and break easily.

2.4 Liquefaction of air

Air becomes liquid at -193°C. Liquid air can occur around non-insulated machines and piping with a temperature lower than -193°C. The surrounding air can condense on the cold material. The liquid air flows off the piping as if it were water and can for example come into contact with persons.

2.5 Vapour clouds

During leakage or blow off of an installation in the case of overpressure, vapour clouds can occur. In these clouds the water is freezing and ice patches can occur on the floor. Also the view is obscured. Entering these clouds can result in danger of suffocation (see next chapter).

3 SUFFOCATION

Suffocation can be described as the loss of life due to lack of oxygen. Normal air consists for 21% of oxygen. For a safe living environment, the oxygen percentage in the ambient air must lie between 19,5% and 22% .

The danger in working with gasses lies in the fact that most gasses are:

- invisible
- odourless
- tasteless
- not tangible

Therefore they cannot be detected by our senses.

Nitrogen, argon and helium are so called inert gasses, i.e. they do not chemically react and therefore do not support oxidation. For that reason they are used for flushing vessels and piping, for high-tech welding and leakage detection. These situations can occur in which piping, vessels etc. are filled with these gasses while they cannot be detected.

Machines in which gasses or liquids under pressure are processed are fitted with an overpressure safety. Via this overpressure safety gasses can be blown off in the environment as a result of which situations can occur in which the oxygen concentration no longer meets the norm.

During evaporation of liquid argon, nitrogen or helium one part liquid will form about 800 parts of gas. When one of these liquids evaporates in a particular space, then the oxygen concentration can drop to a level whereby a life threatening situation will exist.

3.1 Steps to be taken in case of an accident

1. If you see someone collapse, do not try to rescue this person, but leave the area or room as soon as possible and alert someone in possession of a breathing apparatus.
2. Many suffocation accidents have two victims; the person that has collapsed and the one who has assisted the victim.

3.2 Preventive measures

1. Ensure there is proper ventilation in all spaces where gas or liquid argon, nitrogen or helium is used.
2. Connect any blow off valves to piping that leads to the outside air. Ensure that this blow off point is sufficiently far away from the inlet point of the ventilation system.
3. In case of doubt, fit oxygen sensors that measure the oxygen in the environment and raise an alarm in case of danger.

4 FIRE HAZARD

Oxygen is necessary for combustion. The higher the oxygen concentration, the lower the energy necessary to realise ignition. The warmth of the discharge sparks of static electric energy, or rapid compression of oxygen gas can be sufficient to start a fire.

Air can condensate against very cold surfaces. At this point, extremely high concentrations of liquid oxygen occur. When working on these cold surfaces of for example liquid nitrogen or helium piping the same safety guidelines must be used as with oxygen. Therefore, when oxygen is released, there is a high fire hazard.

4.1 Precautions

1. Fuel, an ignition source and oxygen are required for a fire. In case of uncontrolled release of oxygen one can only control the ignition source. Consider e.g. sparks caused by static electricity generated by clothing and sparks generated by electrical equipment such as switches and phones.
2. Ensure there is maximum ventilation.
3. Keep the working environment free from combustible materials as far as is practically feasible.
4. Let the oxygen vent from your clothing for a period of about 15 minutes when you have worked on locations where high concentrations of oxygen might have been present.
5. Valves in oxygen systems must be opened slowly to ensure the pressure increases slowly.
6. Ensure that all parts are degreased to ensure trouble free use in oxygen.
   Parts and pipes for oxygen applications should be cleaned -and have been inspected in accordance with the requirements of "Oxygen clean."
7. Never apply NON-approved grease in oxygen environment, apply only grease which is approved by the German institute BAM (Federal institute for Materials Research and Testing) or similarand must have a certificate that the material is approved for liquid oxygen service. (For example: Klüberalfa YV 93-1202)
8. Materials for gaskets and O-rings in oxygen environment must be approved by the German institute BAM, or similar, and must have a certificate that the materials are approved for liquid oxygen service.

5 DISASSEMBLING PIPING AND FITTINGS

The above-described risks, and the measures to be taken in that respect, are also important when working on cryogen systems where piping sections or fittings have to be disassembled.

Personal protection means, such as gloves, safety glasses and safety shoes must always be worn.

Ensure when disassembling that the system is not pressurized and bear in mind that cold liquids and gasses can escape.
Before starting the disassembly, the product supply must be shut off. Usually this will be done by closing the valve to the storage tank. This valve must be locked in such a way that it cannot be opened by unauthorised persons during the disassembling.

Piping can be under pressure as a result of the still existing system pressure, or by build-up of pressure due to evaporation of the medium. The pressure that is created because the liquid evaporates due to heat ingress, can rise considerably. After closing the supply, the piping will have to be depressurized.

This can be done in various ways:

- When a valve is fitted on the end of the piping which is directly venting to the ambient air, it can be opened carefully.

- When the pressure in the pipeline system has been released by bleeding the system to the outside air through a valve, the section to be removed must be closed off at both ends with seals. Because there is always a safety valve located between two seals in the pipeline system, this is carefully unscrewed and removed. As a result the pipeline section will remain unpressurized. In couplings where clamps are used, caution must always be exercised because some gas under pressure can be present in the coupling itself. In couplings where flanges are used, the bolts can be loosened slightly so that the gas can escape.

ANNEX 1 "SAFETY GUIDELINES DEMACO HOLLAND BV CRYOGENIC EQUIPMENT"

	DANGER	WARNING
	Cryogenic equipment contains fluids at low temperatures. Touching cold parts leads to severe burns.	Don't expose any part of the body to cold parts and keep a safe distance. Use safety glasses, protective gloves and protective clothing.
	Liquified gasses are colourless and odourless. Leaking gasses may result in reduction of oxygen level. This causes rapid suffocation.	Make sure there is enough natural or mechanical ventilation. In contained areas use oxygen level monitoring. Use independent breathing devices.
	High pressure may be present in the system. Due to evaporation of liquid during heat up pressure may rise quickly. This leads to cold gas releasing through pressure safety devices. Breathing cold gas may lead to frostbite of mouth and lungs.	Before opening the installation make sure no pressure is present. Never prevent the release of gas by the pressure relief valves. Keep a safe distance. Use safety glasses, protective gloves and protective clothing. Prevent breathing cold gas.
	Oxygen and hydrogen are high explosive gasses. Take proper precautions when working with oxygen and hydrogen systems.	Keep a safe distance. Don't use open fire or other ignition sources. Make sure the ATEX guidelines are followed.
	Liquid air may condensate on cold areas. This will flow or drip like water. Touching this fluid leads to severe burns.	Don't expose any part of the body to cold parts and keep a safe distance. Use safety glasses, protective gloves and protective clothing.
	Where air condensates on cold areas liquid oxygen may form. This causes a high risk for fire or explosion.	Keep a safe distance. Don't use open fire or other ignition sources.

- Periodically check the pipes for signs of damage or leakage. Cold spots are usually a clear indication that something may be damaged or leaking.
- Periodically check the proper operation of the pressure relief valves.
- Check the national regulations for mandatory periodic monitoring of safety valves and pressure equipment.
- Make sure the pipes and other hardware of the installation is properly supported and protected against tilting, and properly protected against collision by foreign objects, as this may damage the hardware and/or result in leakage of cryogenic fluid.

Conditions for use of standard Demaco Vacuum insulated equipment

When the equipment is used outside of these conditions please contact Demaco.

The following figures are based on a distance between supports of max. 3 m:

Conditions of our standard design:

- Ambient temperature -20°C to +38°C
- Windload Windforce 10 continuous
- Snow and ice load Not relevant
- Earthquake Seismic Zone 0 acc. to UBC
- Max. allowable load at interface (support at interface)
    - Max. force in any direction at interface 100 N, and
    - Max. moment at interface 10 Nm
- Amount of thermal cycles 1000 cycli according to EJMA

Remarks:

- When connecting vibrating equipment to the Vacuum Insulated Pipe we advise to use a hose or bellows to prevent damage of the pipe.
- We advise to use a design pressure equal to or higher than the design pressure of the supply system, to prevent unsafe or unwanted conditions, such as relief of the supply system through the pressure safety valves of the application.
- We advise to use exhaust pipes to reroute blow off or exhaust of devices such as phase separators, gas vents and pressure relief valves to a safe place, away from people.
- Our Vacuum Insulated Equipment is made with a stainless steel jacket suitable for a normal to harsh environment. When using the equipment in a very corrosive environment (seawater or aggressive cleaning agents) please contact Demaco for a suitable solution.
- Our standard equipment is designed for all cryogenic fluids. Please inform Demaco when the equipment is meant for flammable, explosive or poisonous fluids. Special care must be taken during design and production of safety features in this case.
- If liquid Hammer occurs please contact Demaco for a proper solution.